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COURSE OF LECTURES
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VOLUME II.—PLATES.

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A
COURSE OF LECTURES
ON
NATURAL PHILOSOPHY,
BY
JOHN H. PEARSON

A
COURSE OF LECTURES
ON
NATURAL PHILOSOPHY
AND THE
MECHANICAL ARTS.

BY THOMAS YOUNG, M.D.,

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COLLEGE, CAMBRIDGE, AND PROFESSOR OF NATURAL PHILOSOPHY IN THE
ROYAL INSTITUTION OF GREAT BRITAIN.

A NEW EDITION, WITH REFERENCES AND NOTES,

BY THE

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P L A T E V I I I .

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PLATE X.

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PLATE XI.

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PLATE XIII.

Fig. 166. Joints for a tie beam. The joints at A and B cannot be more than half as strong as the entire beam, supposing the adhesion, produced by the pressure of the bolts, as strong as could be required. The joint at C is called a dovetail joint; its strength is a little less than that of A and B, but the adhesion is more easily secured, since a force tending to separate the beams must tighten the joint. P. 128.

Fig. 167. Joints for a tie beam. The joint A, if sufficiently tight, may possess of the strength of the beam. The joint B may be as strong as the beam, if the adhesion were great enough, but it would be difficult to apply sufficient pressure to create such an adhesion, and if the beam were subject to be much shaken, the joint would be a very bad one. P. 128.

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PLATE XIV.

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PLATE XV.

Fig. 189. The form of a wheel or pulley, on which a broad strap runs, the surface being convex : the wheel which drives it is of a similar form, but its upper part only is shown in the figure. P. 135.

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Fig. 198. A chronometer for measuring minute portions of time. The axis A B being turned, either by the handle A or by the weight C, the balls D, E fly out, and carry the weights F, G further from the axis; in consequence of which the increased effect of friction retards the motion, when it becomes too rapid. The barrel H is turned in the mean time, with the axis, and is allowed to descend as the thread at I is uncoiled, so that the point K, which is pressed against it by a spring, describes on it a spiral, which is interrupted whenever the pin K is touched. P. 147.

Fig. 199. The fusee of a watch or clock, the general outline of which forms part of the hyperbola A B, in which the distance of each point from the axis C D is inversely as its distance from the line D E. P. 148.

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Fig. 200. A fusee with an auxiliary spring, for continuing the motion when the watch is wound up. The action of the main spring turns the fusee in the direction A B; the fusee acts on the ratchet wheel A B C by means of the click B, and this wheel impels the toothed wheel D E by the spring C B A, which is supposed to be seen through it. When the watch is wound up, this spring forces back the wheel A B C against the click F, which serves as a fixed point, while the other end continues to act on D E, and to maintain the motion. P. 148.

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Fig. 204. The horizontal scapement, for a watch. The tooth A rests first on the external surface of the cylinder, B C, and then impels it by its inclined face, in the direction B C; it afterwards falls on the concave surface D E, and lastly impels the cylinder in the contrary direction. P. 150.

Fig. 205. The duplex scapement. A B is the pallet, through which the cylinder, and the tooth which rests on it, are supposed to be seen, the point of the tooth being about to escape from the notch towards C. The short tooth D next impels the point of the pallet, and the long tooth E falls on the cylinder. It first rests on the convex surface, and then drops into the notch, which causes a slight recoil in the wheel, and passes by, the tooth F being beyond the reach of the pallet; but on its return, the tooth falls again into the notch; and when it escapes, the pallet is impelled as before. P. 150.

Fig. 206. Mr. Mudge's watch scapement. A, the scape wheel, and one of the subsidiary springs, seen from above; B, a general view of the balance, with both the subsidiary springs, seen from one side. The point of one of the teeth rests at C on the end of the pallet, which is bent so as to detain it until the pin D, which is attached to the balance, sets it at liberty, by striking against the arm E; this arm is then carried on by the balance, to the end of its vibration, and impels it in its return, until the pallet meets the next tooth. The other spring acts alternately in the same manner, but in a contrary direction. P. 151.

Fig. 207. An improvement on Mr. Cumming's scapement for a clock. The tooth A is seen resting on a flat surface at the end of the pallet B: it is disengaged by the descent of the opposite pallet into the position in which it is represented, the pallet B being impelled by it at C. This pallet continues resting on the flat end of the tooth, until the pin D of the pendulum strikes against the arm E, which is carried before it, and impels the pendulum in its descent, until the pallet B acquires the situation in which the opposite pallet is represented, and sets that pallet at liberty from the tooth E, which has raised it. The situation and magnitude of the weights G, H, may be adjusted at pleasure. P. 151.

Fig. 208. Mr. Arnold's watch scapement. The pin A, projecting from the verge or axis of the balance, moving towards B, carries before it the spring B, and with it the stiffer spring C, so as to set at liberty the tooth D, which rests on a pallet projecting from the spring. The angle E of the principal pallet has then just passed the tooth F, and is impelled by it until the tooth G arrives at the detent. In the return of the balance, the pin A passes easily by the detent, by forcing back the spring B. The screw H serves to adjust the position of the detent, which presses against it. P. 151.

Fig. 209. Mr. Earnshaw's scapement. A is the unlocking pallet, B the spring on which it acts, C the detent, holding the tooth D by a pin; E is the point of the principal pallet first impelled by the tooth F, G is the tooth next locked, and H the adjusting screw. P. 151.

Fig. 210. A gridiron pendulum, consisting of three bars of iron, and two of a mixture of zinc and silver. P. 154.

Fig. 211. A compensation balance, as employed by Arnold. The outside of the

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Fig. 212. The compound plate A B rests on two supports, which are adjusted to a proper distance by turning the double screw C, the flexure of the plate by heat raising the bar D, which supports the pendulum, while its effective length is determined by a fixed clip, which is seen below the plate. P. 154.

PLATE XVII.

Fig. 213. A jack for raising weights by the alternate motions of a lever, the clicks on each side being detained in the teeth of the ratchets by the assistance of the springs in which they terminate, and which are connected together. P. 157.

Fig. 214. The mode of supporting a tackle for raising stones in building ; the summit of the triangle, which is composed of three poles, being raised or lowered by means of a rope and pulleys. P. 159.

Fig. 215. A method of raising weights obliquely, by means of a rope passing over a pulley, which is drawn along horizontally. P. 159.

Fig. 216. A B, a section of an inclined plane, belonging to the Duke of Bridgewater's canal ; the boats are drawn into the locks at A, which are then filled with water ; C is the plan of the windlass, by which the descending and ascending boats are connected together, and which is turned by a winch ; D and E are the locks. P. 159.

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Fig. 219. A lewis, for raising stones. P. 161.

Fig. 220. When the centre of gravity A is twice as far from one of the porters B, as from the other C, the first bears one third of the weight, the other two thirds. P. 162.

Fig. 221. When the centre of gravity A is above the line joining the points of support B, C, the load is divided in the ratio of the segments C D, B D, terminated by the vertical line A D ; but it may be supported by two equal forces in the directions B E, C F, found by making G H equal to B G, and joining C H ; the angle G B E being equal to G H F ; the forces and the weight may then be represented by the lines C I, I K, and C K. P. 162.

Fig. 222. A roller with two wheels fixed on its ends, by means of which the slab resting on it may be moved to a considerable distance without leaving the roller behind. P. 164.

Fig. 223. Mr. Garnet's rollers for diminishing friction : their axes being loosely connected by a ring, in order to keep them in their places. P. 164.

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Fig. 224. A pair of friction wheels, supporting one end of the axis of a wheel. P. 164.

Fig. 225. The centre of the wheel A B, passing over the obstacle C, describes the path D E; that of the larger wheel F G, the path H I, which is less steep. P. 164.

Fig. 226. The centre of the wheel A B describes the curved path C D, in passing over the obstacle E, while that of the larger wheel F G has an angle at H. P. 164.

Fig. 227. The wheel A B, moving on a soft road towards B, has to overcome the resistance of the earth at C. P. 165.

Fig. 228. A section of the wheel of a carriage, a little dished, or inclined outwards. P. 166.

Fig. 229. A B and C D being the straps or braces by which a coach is suspended, if the centre of gravity be at E, F, or G, it must move, when the carriage swings, in the curve passing through the respective point. P. 167.

Fig. 230. The mode of harnessing two horses, so as to make them draw conveniently together: when either horse advances so far that the bar A B assumes the position C D, the foremost horse has the disadvantage of acting on a lever equivalent only to E F, while the other horse acts on E C. P. 167.

Fig. 231. A sugar mill. The axis A is turned either by animal force or by water: the liquor is collected in the trough B, and runs off in the channel C. The openings D are for the purpose of adjusting the axes of the rollers. The canes are supplied by the hands of the workmen. P. 170.

Fig. 232. A glazier's vice. The vacuity in the middle shows the form of the section of the lead which is drawn through it. P. 171.

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Fig. 234. An engine for driving piles, on Vauloué's construction. The horses, drawing at A, B, raise the weight C, held by the tongs D, fixed in the follower E, which are opened, when they reach the summit, by being pressed between the inclined planes F, G, so as to let the weight fall. At the same time the lever H is raised by the rope I, and presses on the pin K L, so as to depress the lever M N, and draw the pin O out of the drum P Q; the follower then descends, and uncoils the rope, its too rapid motion being prevented by the counterpoise R, acting on the spiral barrel Q. The motion is regulated by the fly S, the pinion of which is turned by the great wheel T. P. 173.

Fig. 235. The rollers of the slitting mill. P. 174.

Fig. 236. A simple plough. A is the coulter, for dividing the ground; B the share, fixed on the mould board C, for turning it to the right hand; D is the rest, and E, F, the handles. P. 175.

Fig. 237. Section of a threshing mill. The corn is drawn in by the rollers or feeders A, B: it is beaten by the revolving beaters C, D, and the straw is drawn out by the rakes E, F, which discharge it at G; the grain falling through the arched bottoms H I, I G, which are formed like sieves. P. 178.

Fig. 238. A corn mill, with some of the improvements made in America, by Mr. Ellicott and Mr. Evans. The corn being poured into the funnel A, is conveyed by the revolutions of a spiral B C, to C, whence it is raised, by the chain of buckets C D, to be cleaned by the revolving sieve E, and the fan F; it is then deposited in the granary G, which supplies the funnel or mill hopper H; this being perpetually agitated by the iron axis of the upper mill stone, shakes it by degrees into the perforation of the stone; it escapes, when ground, at I, and is conveyed, by means of the carrier K L, and the elevator L M, to the cooler N, where it is spread on a large surface: it passes afterwards to the bolter O, and is received in the binn P, from whence it is taken to be packed in sacks or barrels. Q represents the surface of a mill stone, cut into furrows, in order to make it act more readily on the corn. P. 179.

PLATE XIX.

Fig. 239. The surfaces of the fluid in the bent tube A B remain on the same level, in the same manner as if the tube were absent, and the fluid made a part of that which is contained in the reservoir C D. P. 197.

Fig. 240. The bucket A being suspended by the rope B, and made to revolve rapidly round its axis, the surface of the water assumes a parabolic form. P. 198.

Fig. 241. A heavier fluid being contained in the upper part of the bent tube A B, which is immersed in the lighter fluid, filling the vessel C D, the fluid in the tube remains in a state of tottering equilibrium, when its surfaces are in the same level. P. 198.

Fig. 242. The fluid A B C presses on the bottom of the vessel B C with the same force as if the vessel were of the form B C D E. P. 199.

Fig. 243. The portion A B C D of the fluid being supposed to be congealed, and then to form a part of the vessel, the pressure on the bottom would remain unaltered. P. 199.

Fig. 244. The weight A may be supported by the pressure of a small quantity of fluid, either by making the surface of the vessel B C very large, and the height of the tube D E moderate, or, while the vessel F remains of a moderate size, by making the height of the tube G H very great. P. 199.

Fig. 245. The pressure on any small part of the side of the vessel A B, at C or D may be represented by the line C E, D F, and the whole pressure on the side by the triangle B G, of which the centre of gravity is at H; and if the side A I be supported by a single prop, it must be placed at the point K, the height of which is equal to that of H. P. 200.

Fig. 246. If the height of the surface A above B be to B C as the specific gravity of the fluid in B C to that of the fluid in A B, the fluids will support each other. P. 201.

Fig. 247. Two square beams floating at the depths shown at A and B, will have a certain degree of stability, but if they sink, as at C, they will overset. But a beam of the breadth shown at D will always float securely. P. 202.

Fig. 248. A jar containing images of fishes, with bubbles of air in them, which sink when the cover of the jar is pressed with the hand. P. 202.

Fig. 249. Dr. Hooke's semicylindrical counterpoise, by means of which a vessel is kept always full. P. 203.

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* Ph. Tr. 1665, p. 231.

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jet is supplied by the water of the cistern G, which is pumped up at H from a reservoir: it is drawn out, together with the air that is extricated from it by the air pump I, which throws it into the cistern K, whence the pump L raises it to the cistern M; and it enters the boiler through a valve, which opens whenever the float N descends below its proper place. The pipes O and P serve also to ascertain the quantity of water in the boiler. The piston rod is confined to a motion nearly rectilinear by the frame Q; the fly wheel R is turned by the sun and planet wheel S, T; and the strap U turns the centrifugal regulator W, which governs the supply of steam by the valve or stopcock X. P. 267.

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PLATE XXV.

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Fig. 351. The structure of the left ear, seen from above, the upper part of the canal being supposed to be removed. A is the auditory canal, B the membrane of the tympanum, C the hammer, D the anvil, E the stirrup; F the place of the canals,

which are higher than the parts represented, G the place of the cochlea, H the round aperture. P. 302.

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PLATE XXVI.

Fig. 357. The right half of the human larynx. A B C is the outline of the cricoid cartilage, D E F G H of the thyroid, and I K L of the arytaenoid cartilage; M is the epiglottis, N K the upper ligament of the glottis, O P the lower ligament, and Q the trachea. P. 313.

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lines perpendicular to DE at any such distances, that BK may be to BL in a certain proportion, which is that of the sines of the angles of incidence ABM, CBM, to those of the angles of refraction FBN, GBN. BO and BP are the reflected portions of the rays. P. 322.

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PLATE XXVII.

Fig. 375. A is an actual focus of diverging rays, B an actual focus both of converging and of diverging rays, C a virtual focus of converging rays, and D a virtual focus of diverging rays; A and B, B and C, and C and D are foci conjugate to each other, with respect to the refractions of the three lenses. P. 325.

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Fig. 383. A, a pencil of parallel rays, made to converge, by a double convex lens of crown glass, to the centre of curvature of one of its surfaces. B a double con-

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PLATE XXVI.

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PLATE XXVII.

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PLATE XXX.

Fig. 436. A section of the human eye. A is the cornea; B the aqueous humour, in which the uvea hangs; C the crystalline lens; the ciliary processes being between it and the uvea; D the vitreous humour; EFG is the choroid coat, lined by the retina; HIK the sclerotica, and L the optic nerve. P. 350.

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PLATE XXXI.

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Fig. 456 .. 463. The appearances of different nebulae. From Dr. Herschel. P. 391.

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PLATE XXXII.

Fig. 471. A representing the sun, B the earth, and C the planet *Mars*; supposing *Mars* and the earth to set out together from D and E, the angle D A C was determined by Kepler from calculation, and the angles B A D and A B C by observation; whence it was easy to construct the triangle A B C, and to find the proportion of A B to A C. P. 402.

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* Hist. et Mém. 1771, p. 458.

PLATE XXXIII.

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Fig. 479. The appearance of Saturn, with his ring, from Dr. Herschel. P. 408.

Fig. 480. The appearance of the moon, in an inverted position. The figure is copied from Mr. Nicholson's plate, the references from Cassini and Lalande. Eq. is the place of the moon's equator. P. 408.

Names of the spots, according to Riccioli, and Hevelius.

1 Grimaldus	or Palus Mareotis	26 Hermes	Mons Bodinus
2 Galileus	Mons Audus	27 Dionysius	
3 Aristarchus	Mons Porphyrites	(d) Albategnius	
4 Keplerus	Loca paludosa	29 Plinius	Promontorium Acherusia
5 Gassendus	Mons Cataractes	30 S. Theophilus	Mons Moschi
6 Schikardus	Mons Troicus	31 Fracastorius	Lacus Thospitis
7 Harpalus	Insula sinus hyperborei	32 Censorinus	Promontorium acutum
8 Heraclides	Caput mulieris	33 Messala	
(b) Vulcanus		34	Promontorium Somnii
9 Lansbergius	Insula Malta	35 Proclus	Mons Corax
10 Reinoldus	Mons Neptunus	36 Cleomedes	Montes Rhiphai
11 Copernicus	Mons Aetna	37 Snellius	Mons Paropamisus
12 Helicon	Insula erroris	38 Petavius	Petra Sogdiana
13 Capuanus	Regio Cassiotis	39 Langrenus	Insula major
14 Bullialdus	Insula Creta	40 Taruntius	Sinus Phasianus
15 Eratosthenes	Insula Vulcania	A Mare Humororum	
16 Timocharis	Insula Corsica	B Mare Nubium	
17 Plato	Locus niger major	C Mare Imbrium	
18 Archimedes		D Mare Nectaris	
(a) Aratus		E Mare Tranquillitatis	
19 Insula sinus medii		F Mare Serenitatis	
20 Pitatus	Mare mortuum	G Mare Foecunditatis	
21 Tycho	Mons Sinai	H Mare Crisium	
22 Eudoxus	Mons Carpathes		
23 Aristoteles	Mons Serrorum		
24 Manilius	Insula Berbicus		
25 Menelaus	Byzantium		

Fig. 481..483. The satellites of Jupiter, Saturn, and the Georgian planet, at their proper distances, in proportion to the diameters of the planets, shown on the same scale. P. 408.

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PLATE XXXIV.

Fig. 486. The gravitating body ABC , being supposed to revolve on the axis AC , the fluid column BD must be longer than ED , in order to support its pressure. P. 412.

Fig. 487. If A represent the place of the sun, B that of the earth, and C that of the moon, taking AD to AC as the square of AC is to the square of AB , AD will represent the sun's attraction acting on the earth, and CD the disturbing force, which, together with AD , makes up AC , the force acting on the moon; and it is obvious that, when the nodes are in any oblique situation, as EF , the force being directed to some point D , between B and A , while the moon moves from G to H , the force CD will tend to lessen the inclination, while the moon is ascending from E towards C , and to cause the node E to move back towards G , and, when it is again descending towards F , the inclination will be increased, and the node F made to recede towards H , until the moon arrives at H , and the force becomes directed to a point on the other side of B ; the nodes only advancing while the moon is between H and F , or between G and E . P. 413.

Fig. 488. A body attracted towards the centre A , and descending from B in the ellipse BCD , has the inclination of its orbit to the revolving radius AB , AC , AD , perpetually changed, until at D it becomes perpendicular to it: but when the force increases more rapidly, the radius does not become perpendicular to the orbit till it arrives at E , and the line of the apsides AD moves forwards to E . P. 414.

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Fig. 490. $NE\ SW$ being the horizon, and Z the zenith, $EA\ W$ shows the sun's apparent path in London at the time of the equinoxes, BCD at midsummer, and $F\ GH$ at midwinter, projected orthographically, as if the circles were described on the surface of a globe, and viewed from a great distance. The circle IKL is the boundary of twilight, supposing it 18° below the horizon, and its intersections with the sun's path show the beginning and end of twilight, as at I and K . P. 418.

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Fig. 492. Venus is at her greatest elongation or angular distance from the sun A , when situated as at B , with respect to the earth at C ; and she is stationary at D , when she is moving with the same velocity as the earth, with respect to the direction of the earth's motion, the line ED being then more oblique, with respect to a fixed line, than either before or after. P. 418.

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Fig. 498. The shadow of the moon falling on the earth. The true shadow not

extending here to the earth, the cone formed by the continuation of its outlines marks the extent of the parts in which the eclipse appears annular. P. 420.

Fig. 499. The termination of the moon's disc in a solar eclipse. From Dr. Herschel. P. 420.

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PLATE XXXV.

Fig. 502. AB being the earth's axis, the circle ACB is the meridian of the place C , and CD represents the plane of its horizon. P. 426.

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Fig. 505. A method of constructing a dial on any given plane. ABC is the elevation of the pole, or more generally, the angle which the surface makes with the gnomon AB . The circles are divided into equal parts, and 1, 2, 3, 4, 5, 6 are the hour lines, B being the place of the gnomon. The reason of this construction will appear by comparing the circle in the last figure with the ellipsis which is formed on the horizontal surface. P. 427.

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Fig. 507. A mural quadrant, with its telescope; AB is the plumb line, for adjusting the instrument, and C the counterpoise for the telescope. P. 429.

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Fig. 509. A transit circle, resembling Mr. Wollaston's, with a horizontal circle, by means of which both altitudes and azimuths may be measured. A is a microscope for viewing the plumb line, B another for reading off the divisions of the horizontal circle; C and D are spirit levels. P. 429.

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PLATE XLI.

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* Ph. Tr. 1757, p. 329. Account of Methods, 4to, 1758.

† Churchman's Magnetic Atlas, 1794.

ascertained by that of the case B, which is fixed on it. The compass is fixed in a horizontal position, by means of a double suspension on the gimbals E. G. Instead of this suspension, Mr. de Caillock makes the bottom of the box in the form of a hollow cone, resting on a point, and attached with a weight which brings the centre of gravity below the point of support, as in H. P. 536.

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Fig. 540. Redwood's double thermometer. P. 541.

Fig. 541. John's Whetstone hygrometer. A, the slip of whetstone; B, a spiral spring, serving to keep it stretched; C, the index. P. 544.

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* Pl. Pl. 1795, p. 329. Account of Methods, &c. 1795.

† Chavannes's Map, No. 1791.

Fig. 1.

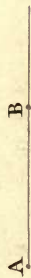


Fig. 2.



Fig. 3.

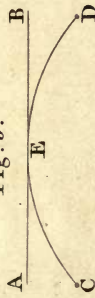


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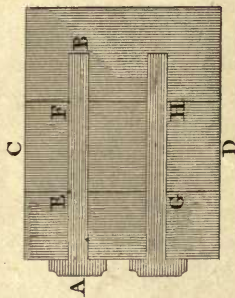


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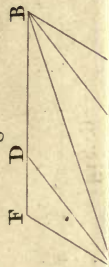


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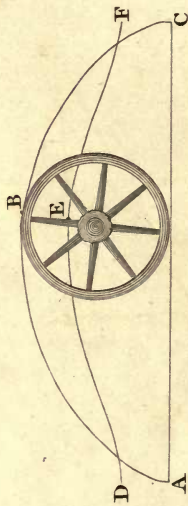


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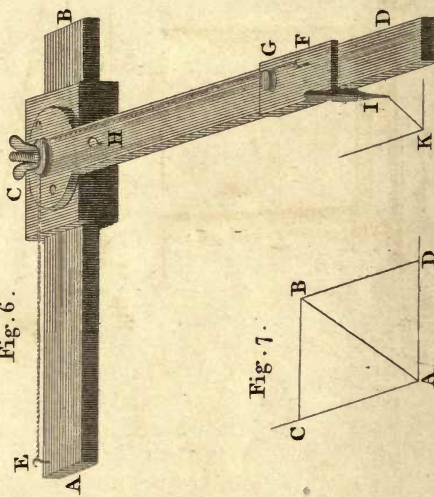


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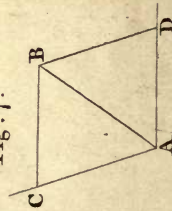


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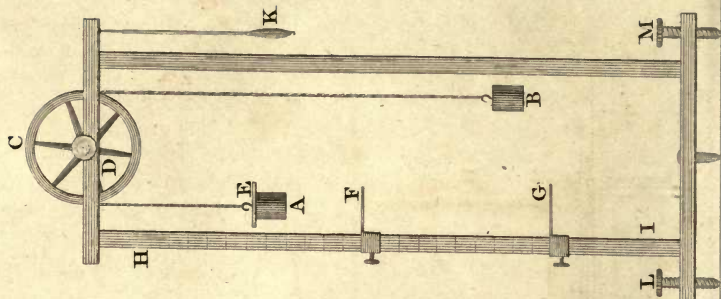


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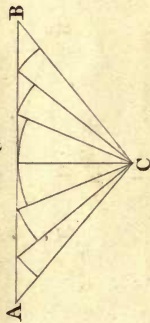


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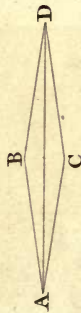


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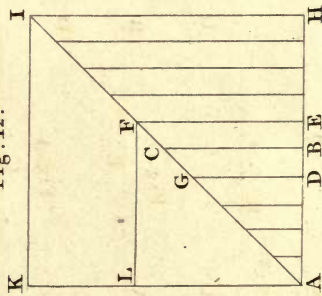


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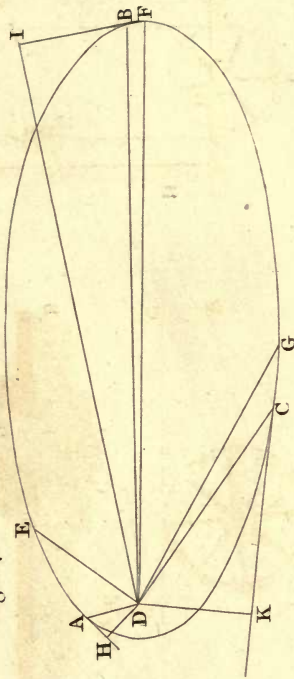
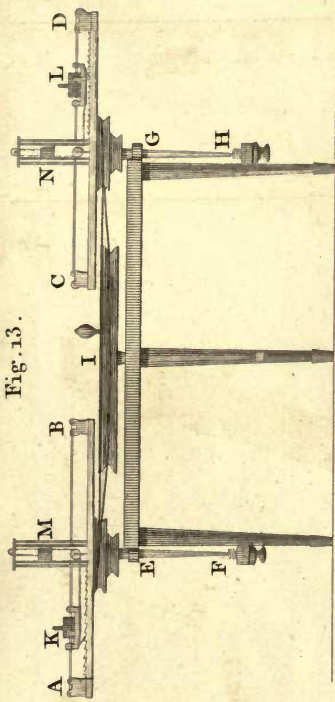


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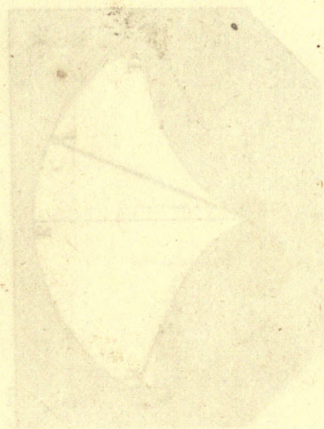


PLATE II.

Fig. 15.

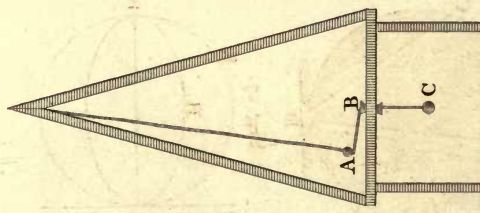


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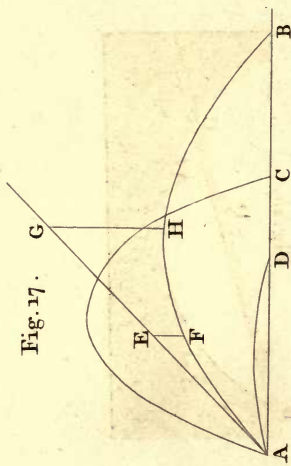


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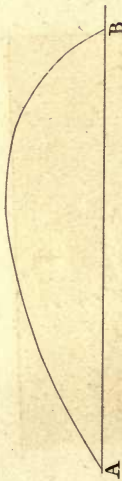


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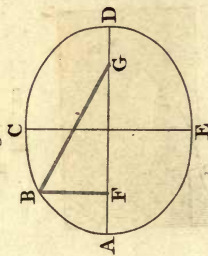


Fig. 20.



Fig. 21.

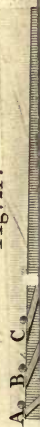


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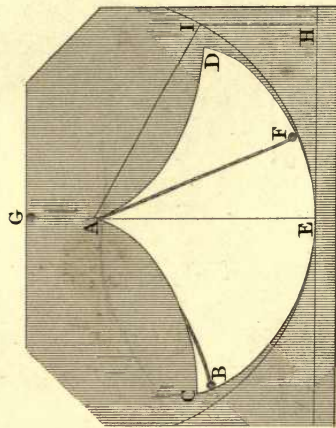
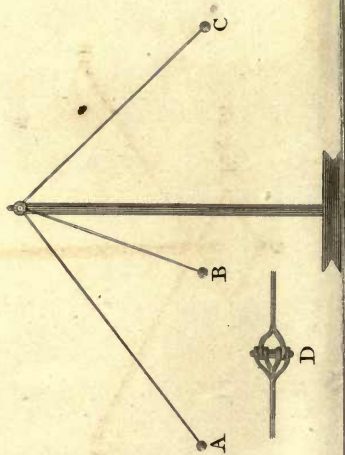


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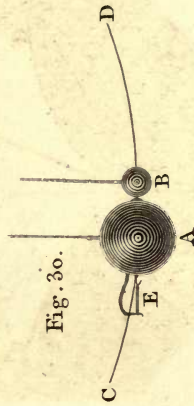
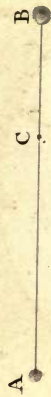
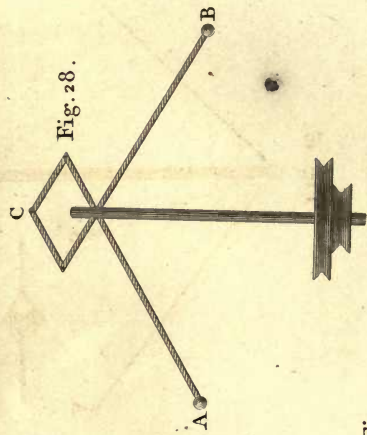
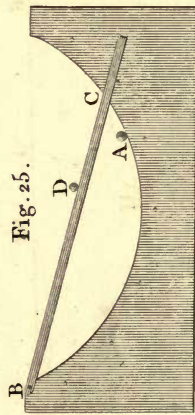
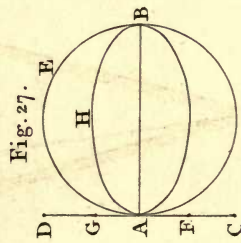
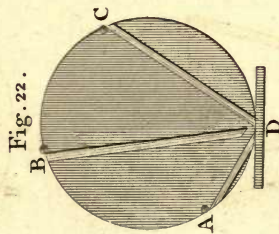
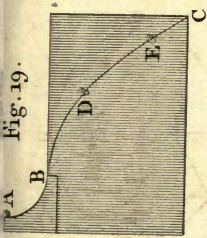


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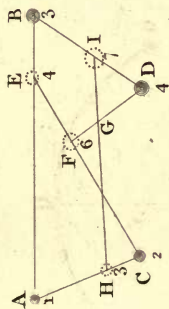


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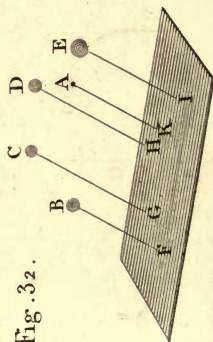


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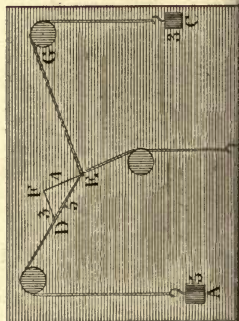


Fig. 37.



Fig. 38.

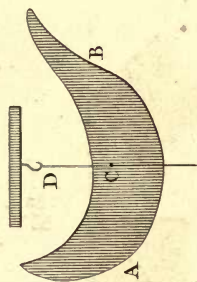


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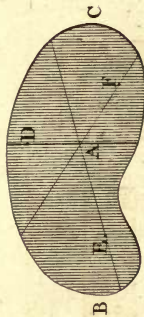


Fig. 40.



Fig. 45.

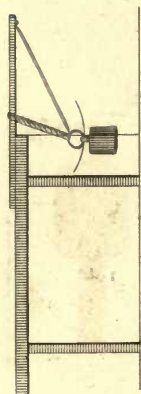


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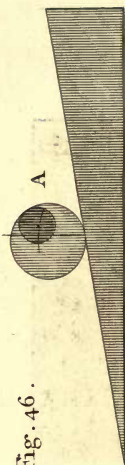


Fig. 47.



Fig. 41.



Fig. 42.



Fig. 43.

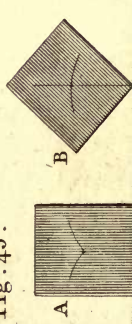


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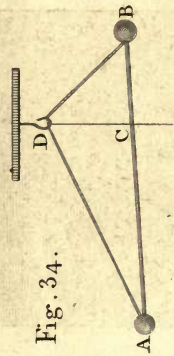


Fig. 35.

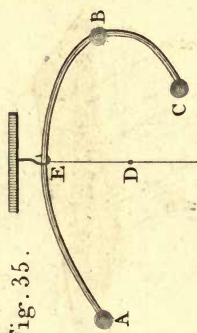


Fig. 36.

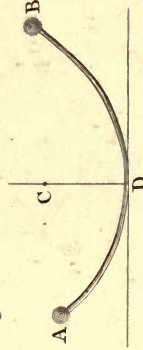


Fig. 48.

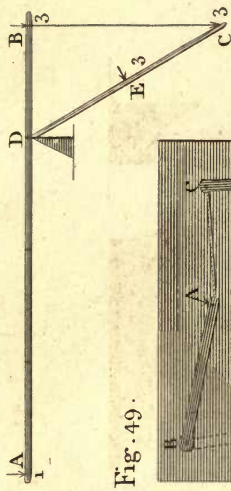


Fig. 49.

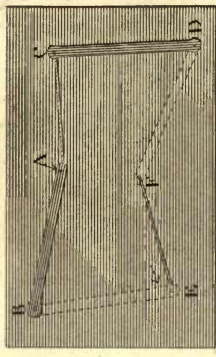


Fig. 50.

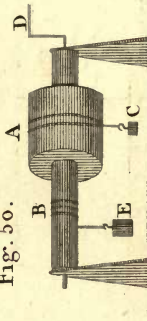


Fig. 44.

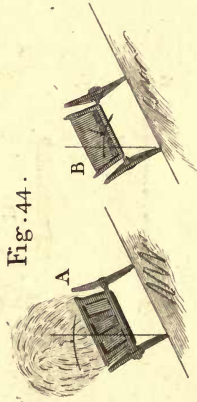


PLATE IV.

Fig. 51.

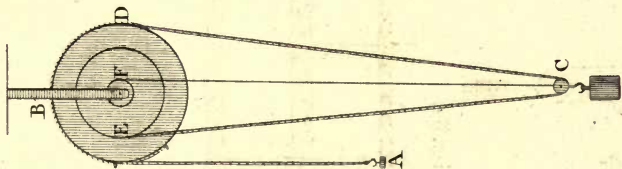


Fig. 52.

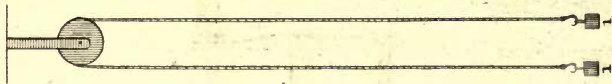


Fig. 53.

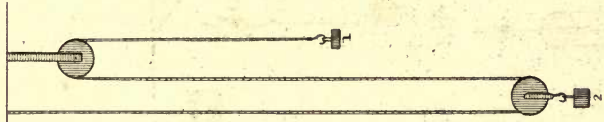


Fig. 54.



Fig. 55.



Fig. 56.



Fig. 57.

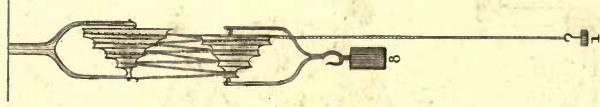


Fig. 58.



Fig. 59.



Fig. 60.



Fig. 61.



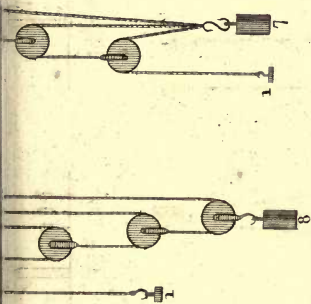


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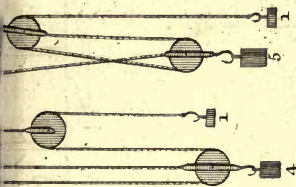


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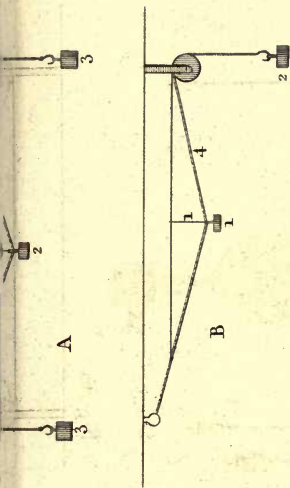
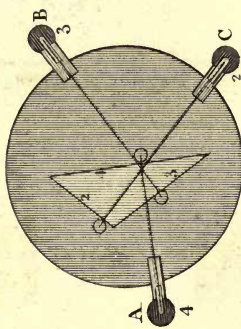
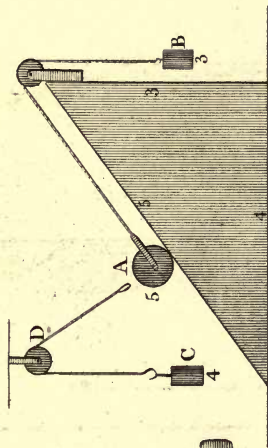
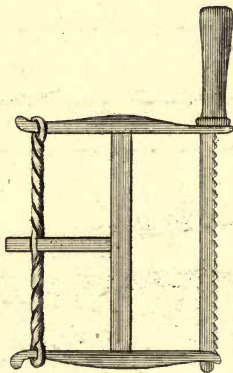


Fig. 64.



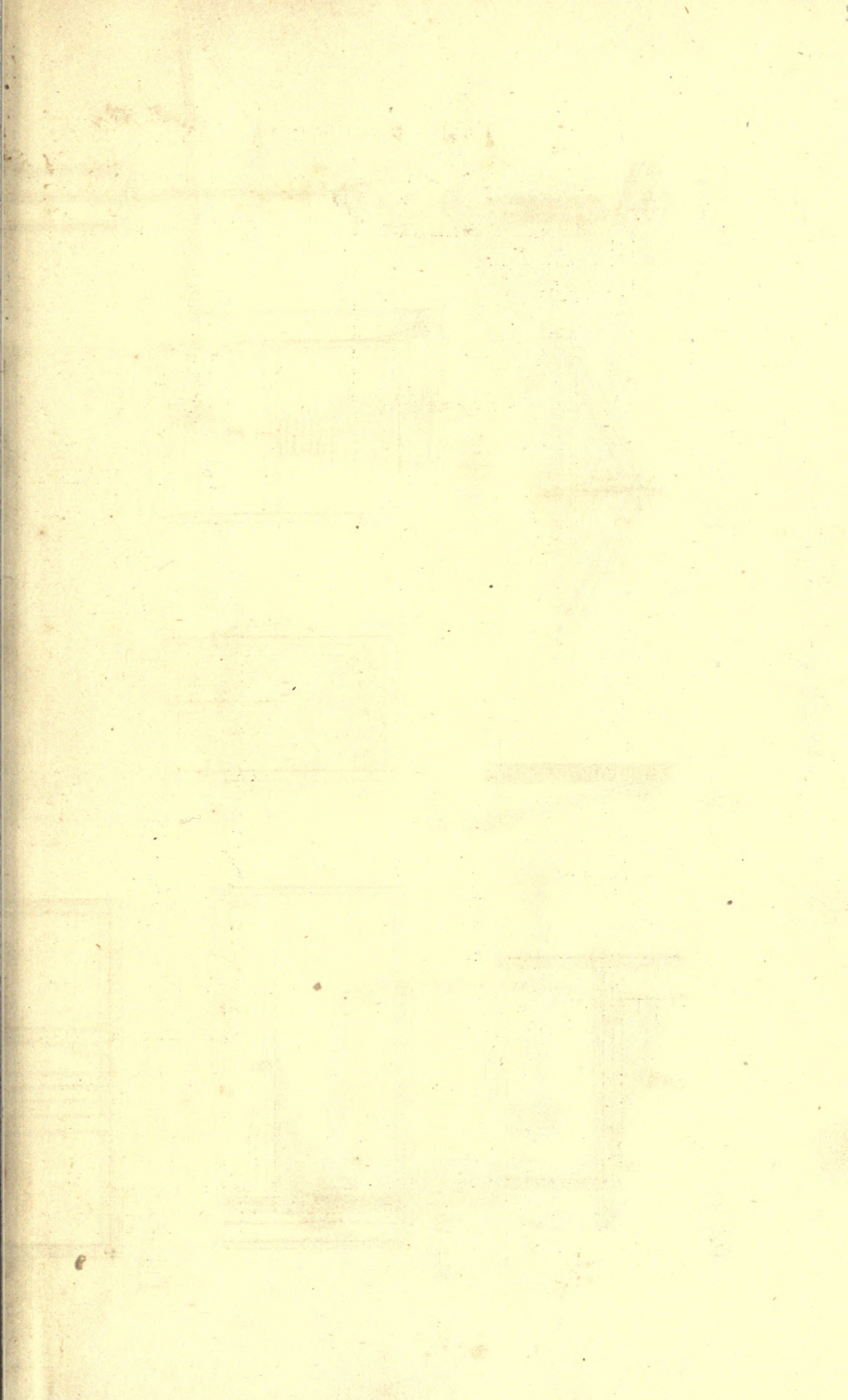


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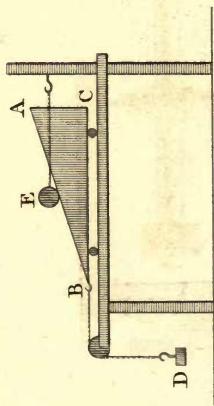


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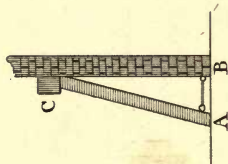


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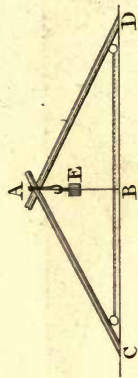


Fig. 69.

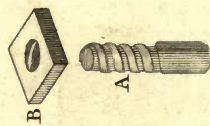


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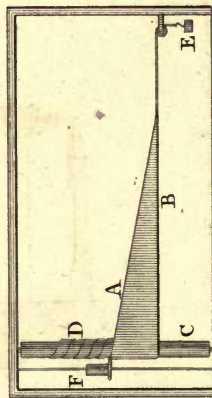


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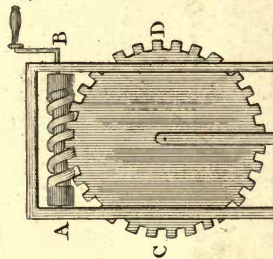


Fig. 71.

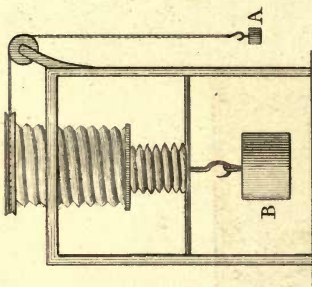


Fig. 75.



Fig. 72.

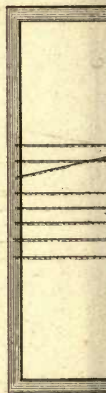
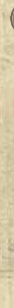


Fig. 73.



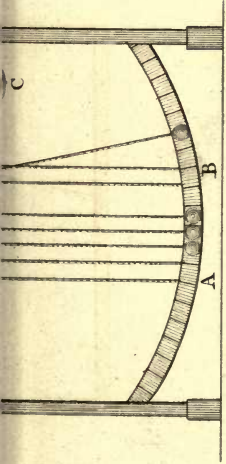


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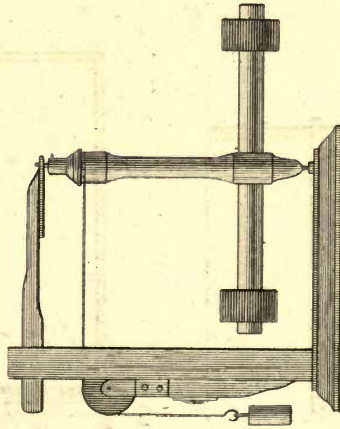
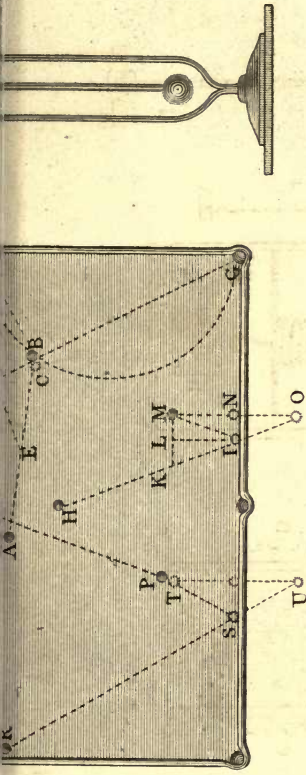
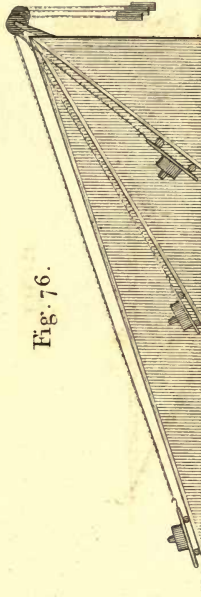


Fig. 76.



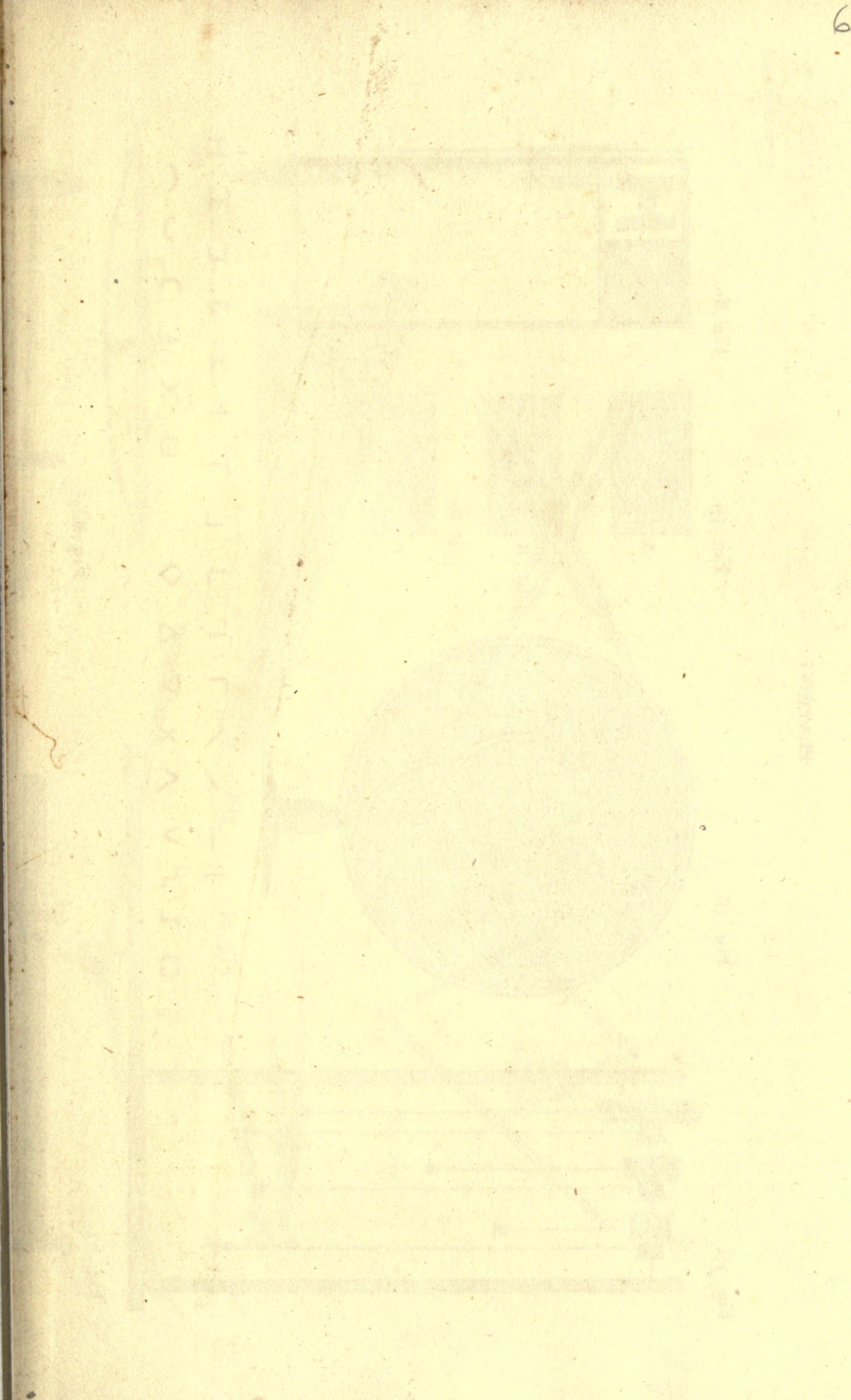


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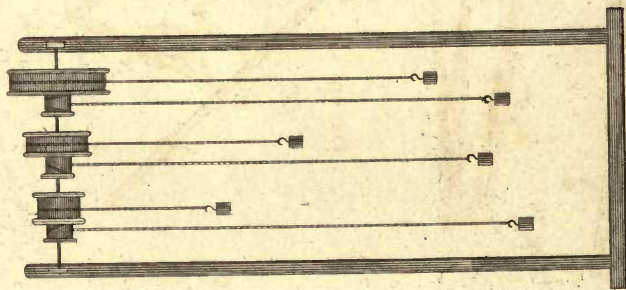


Fig. 78.

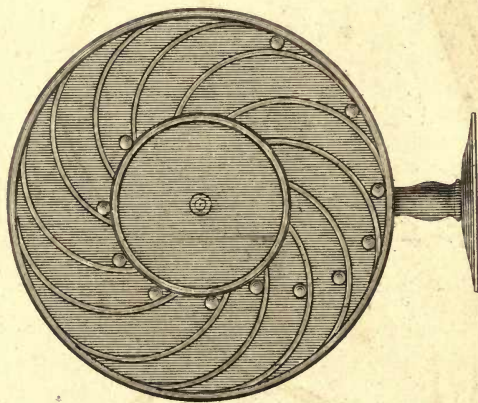


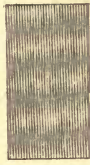
Fig. 79.



A



B



C

Fig. 80.

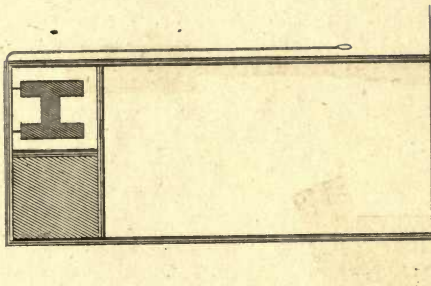


Fig. 81. | - \ / 7 7 L T + L J C I H
 □ 2 5 v ^ x v Δ ◇ O X C D) (

Fig. 82.



Fig. 83.



Fig. 84.

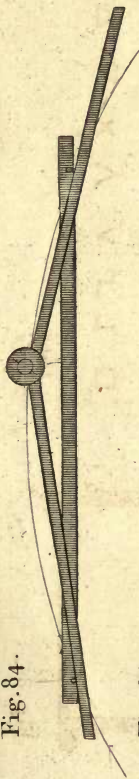


Fig. 85.



Fig. 86.



Fig. 87.

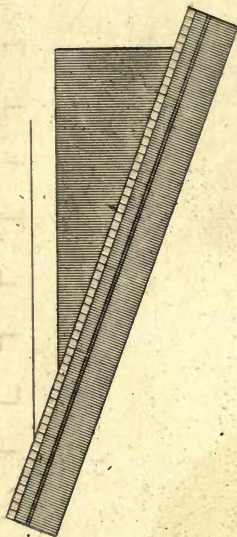


Fig. 88.



Fig. 89.

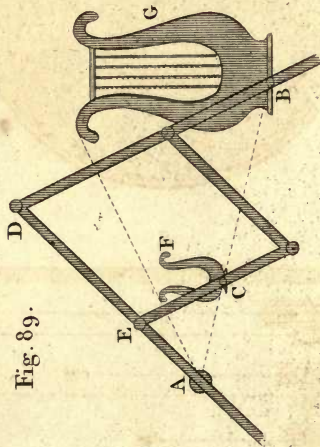


Fig. 90.

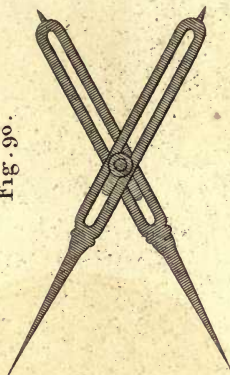


PLATE VII.

Fig. 91.

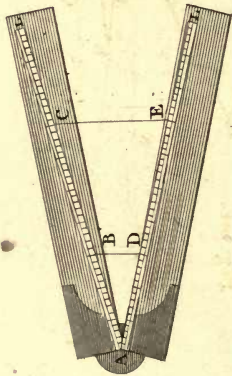


Fig. 92.

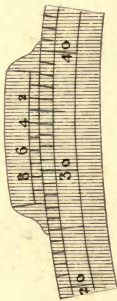


Fig. 94.

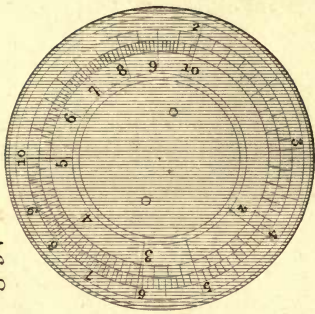


Fig. 93.

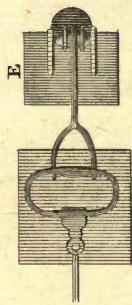
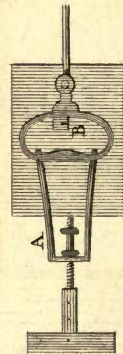
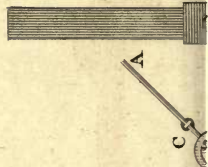
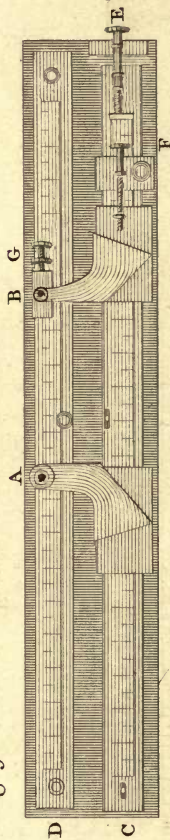


Fig. 96.



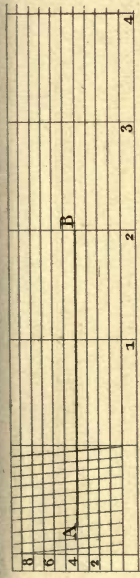


Fig. 98.



Fig. 99.

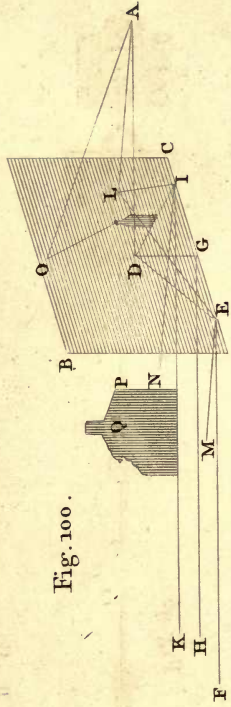


Fig. 100.

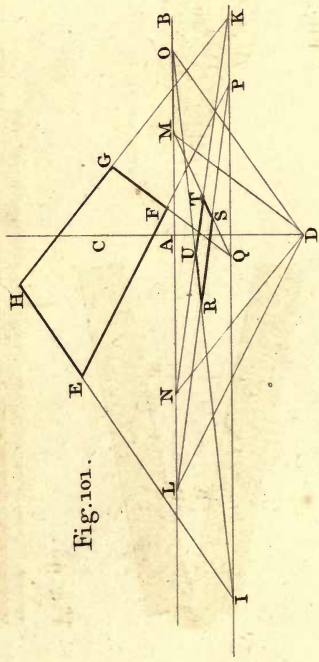


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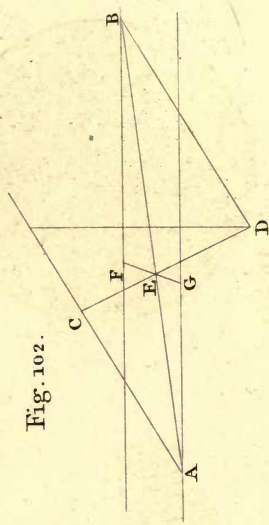


Fig. 102.

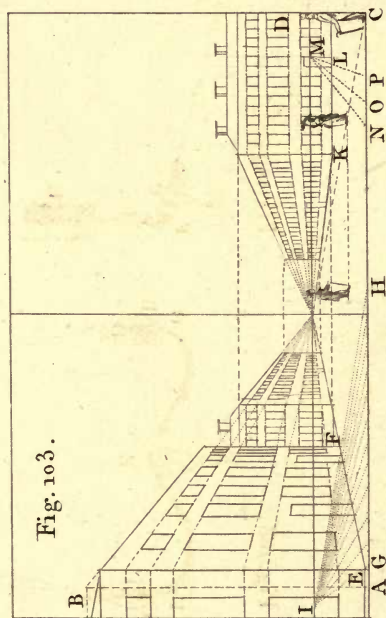


Fig. 103.

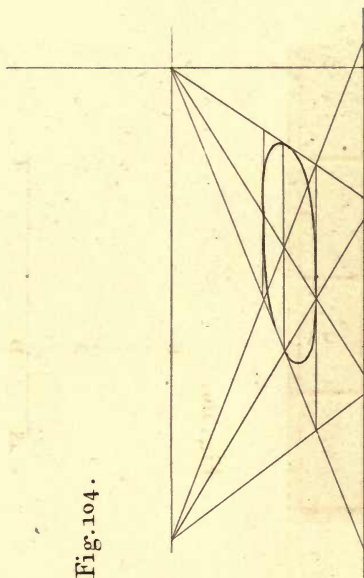


Fig. 104.

Fig. 105.

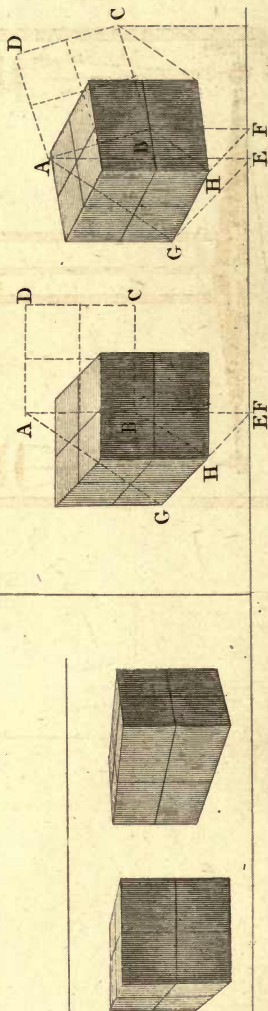


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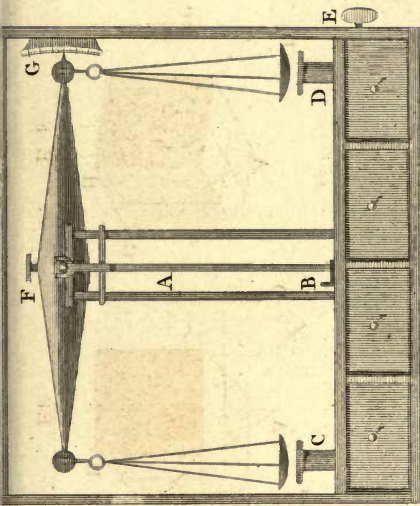
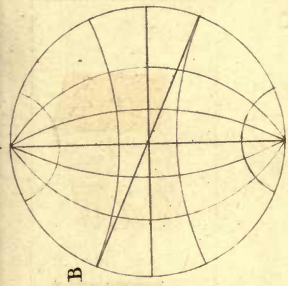
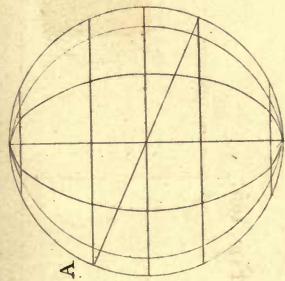


Fig. 108.

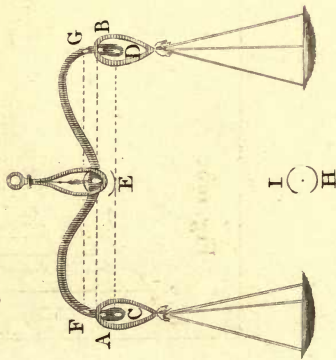


Fig. 109.

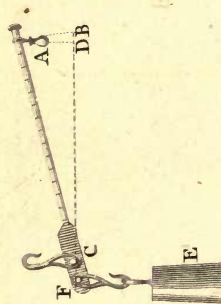


Fig. 110.

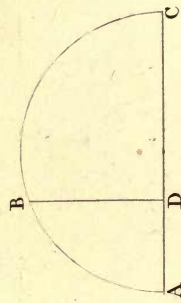




PLATE IX.

Fig.m.

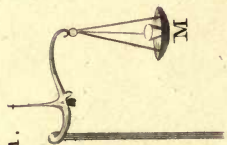


Fig.n2.

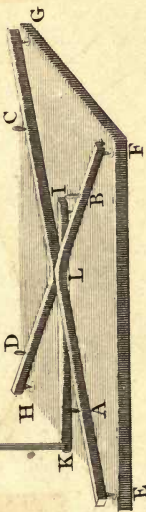
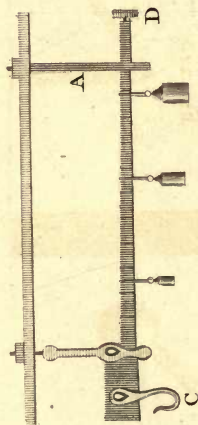


Fig.n4.

Fig.n5.



Fig.n3.

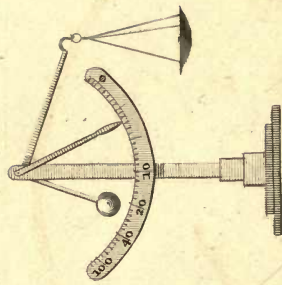


Fig.n8.

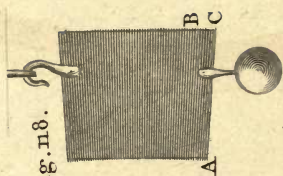


Fig.n7.

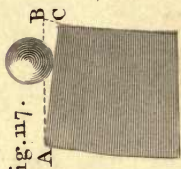


Fig.120.



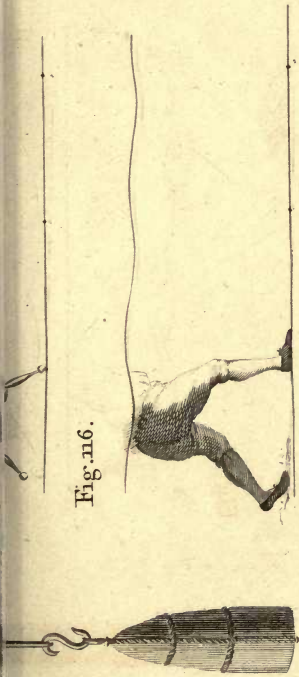


Fig.n6.

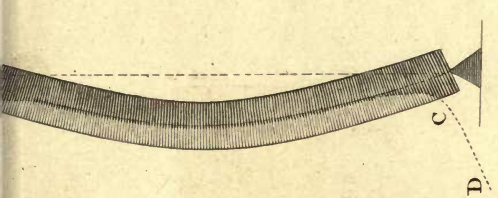


Fig. 122.

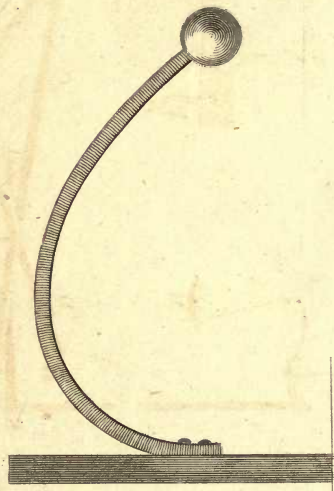


Fig. 121.

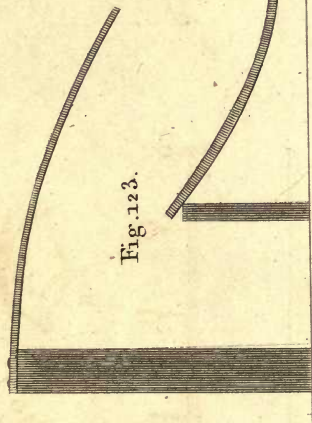


Fig. 123.

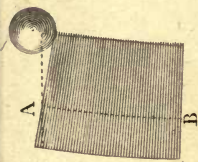


Fig. 124.

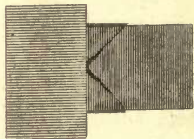


Fig. 125.

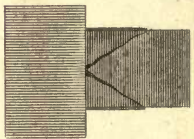


Fig. 126.

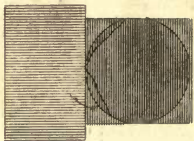


Fig. 127.

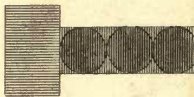


Fig. 131.

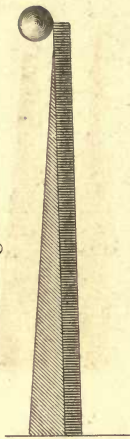


Fig. 132.

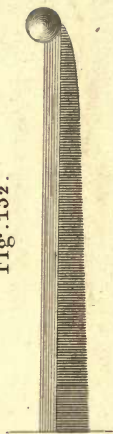


Fig. 128.

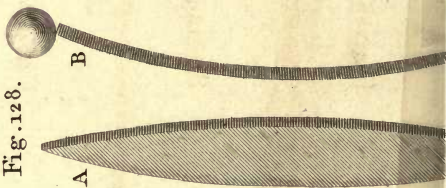


Fig. 129.

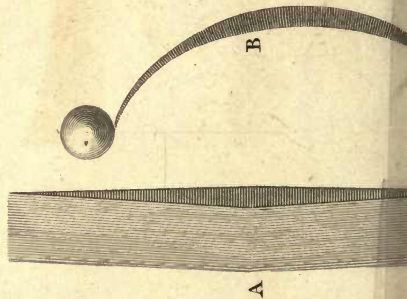


Fig. 130.

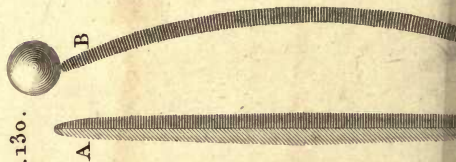


Fig. 133.

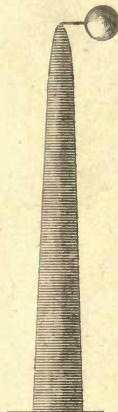


Fig. 134.

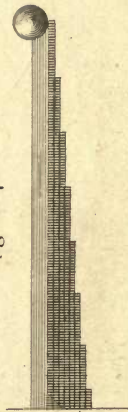


Fig. 135.

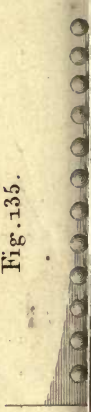


Fig. 136.

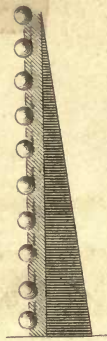


Fig. 137.



Fig. 139.



Fig. 140.

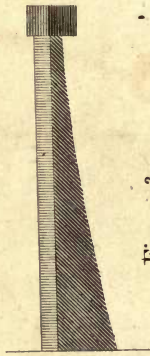


Fig. 142.



Fig. 143.



Fig. 145.



Fig. 146.

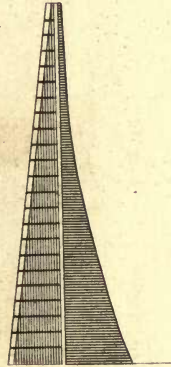


Fig. 138.



Fig. 141.



Fig. 144.

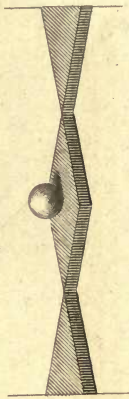


Fig. 147.

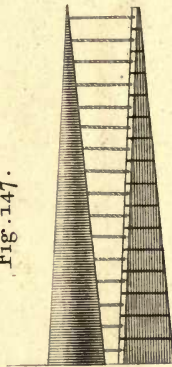


PLATE XI.

Fig. 148.

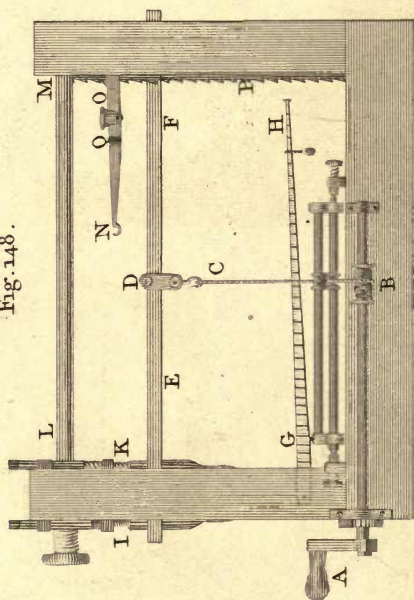


Fig. 149.

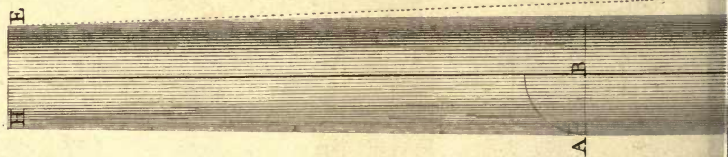


Fig. 150.

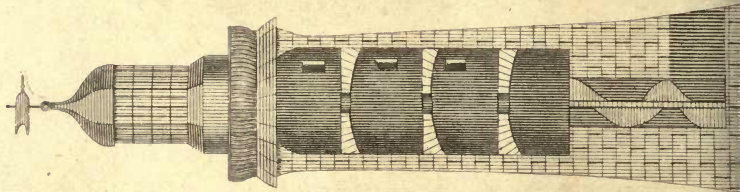
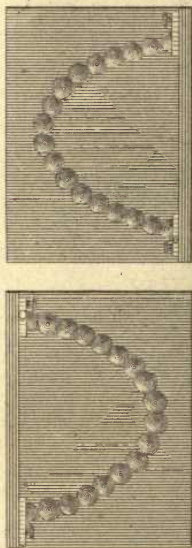


Fig. 151.



Fig. 152.



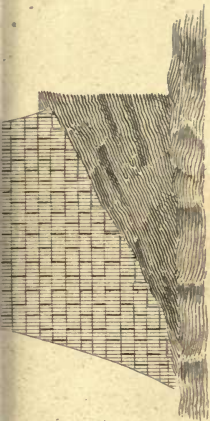
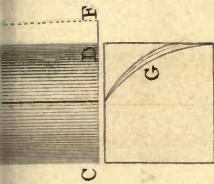
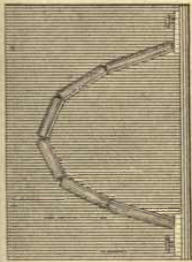
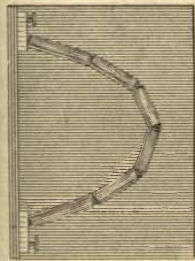


Fig. 154.

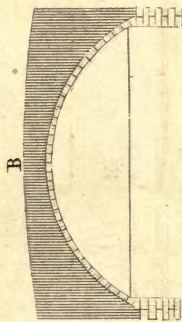
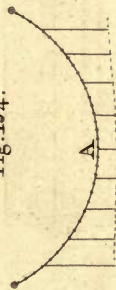


Fig. 155.

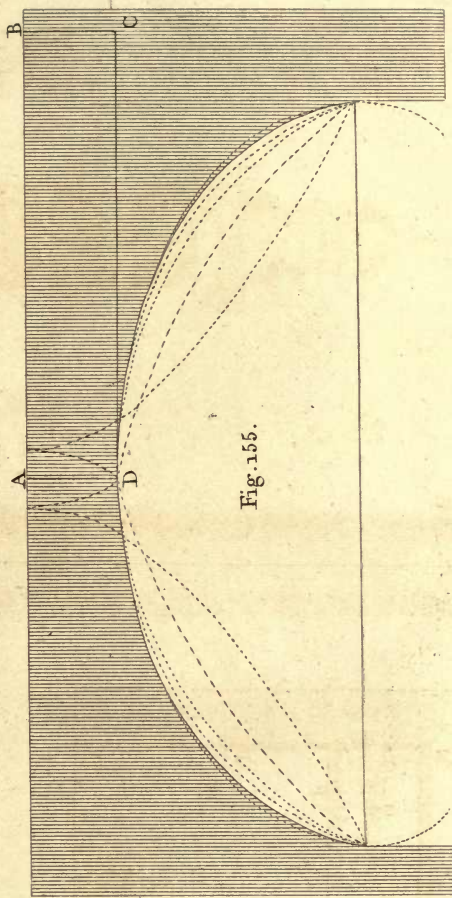


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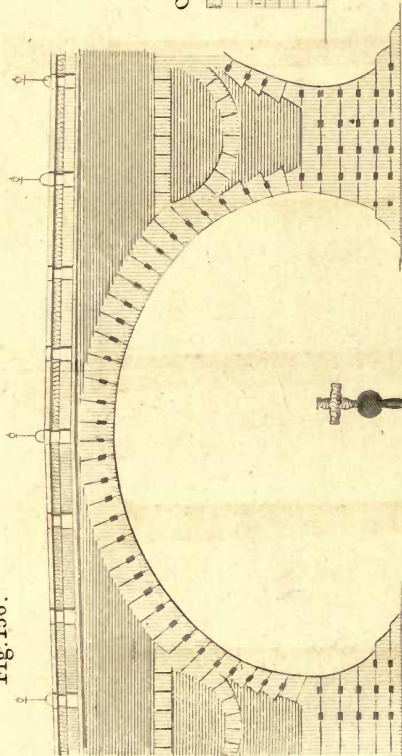


Fig. 157.

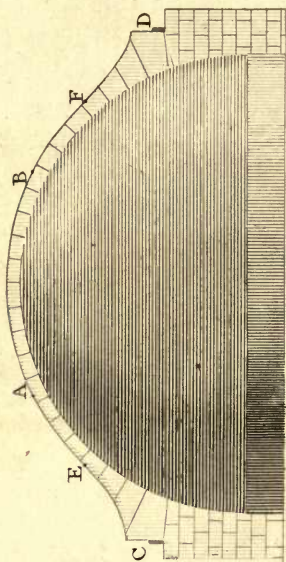


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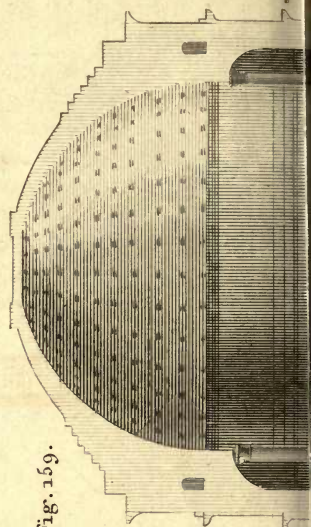


Fig. 158.

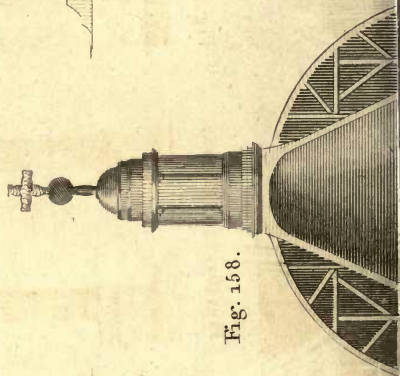




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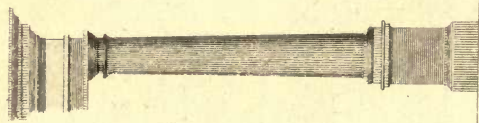


Fig. 161.



Fig. 162.



Fig. 163.



Fig. 164.



Fig. 165.

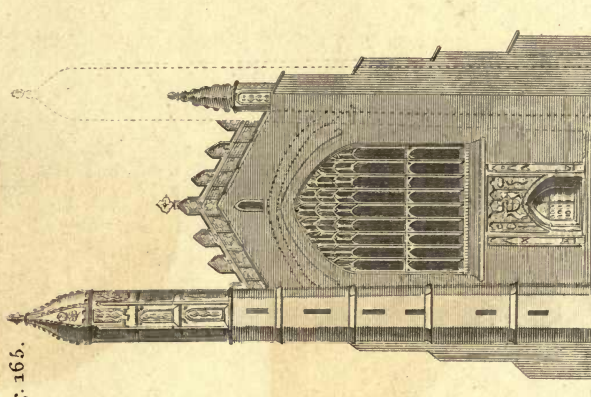


Fig. 166.



Fig. 167.



Fig. 168.



Fig. 169.



Fig. 170.



Fig. 171.



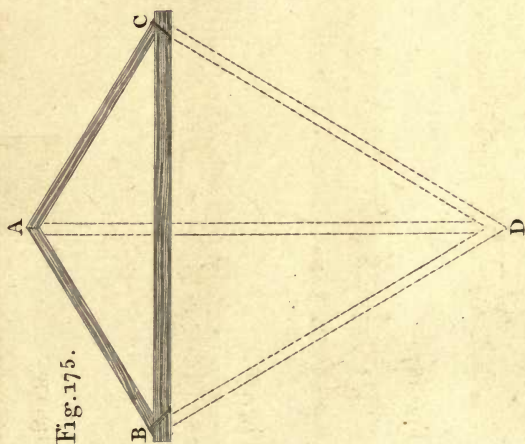


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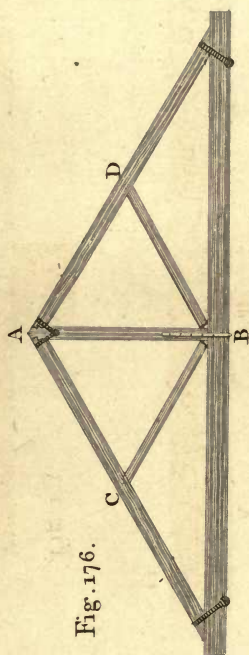


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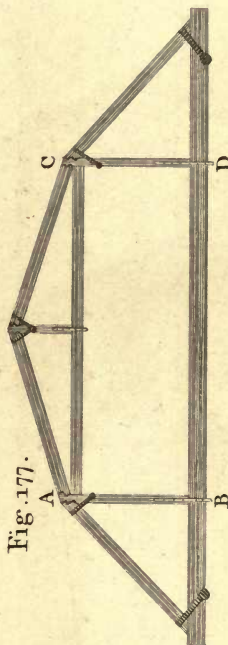


Fig. 177.

Fig. 178.

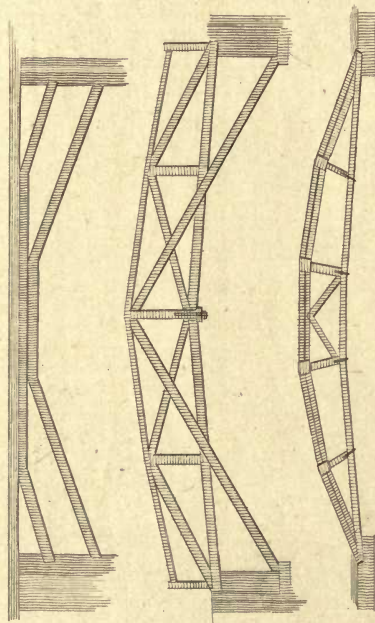


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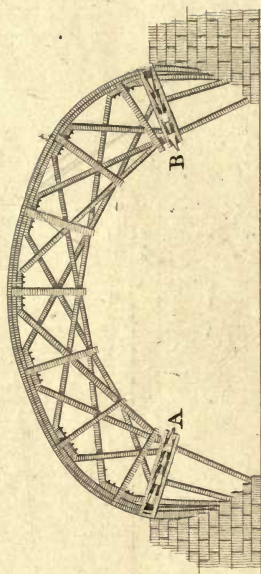


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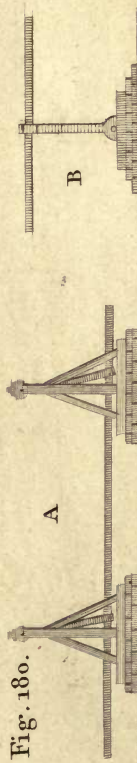


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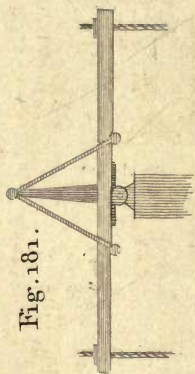


Fig. 182.



Fig. 183.



Fig. 184.



Fig. 185.

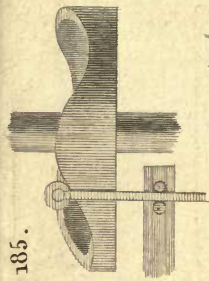


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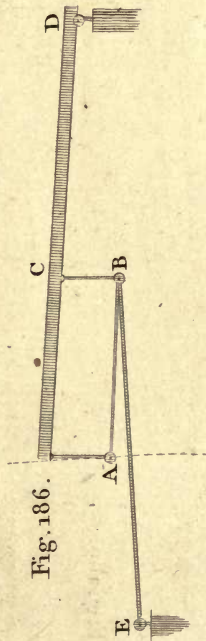


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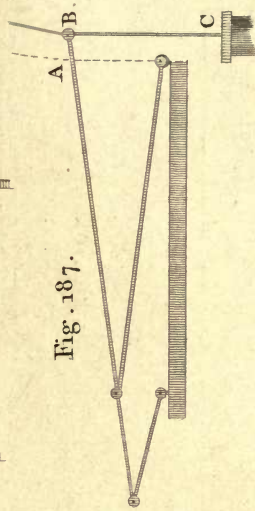


Fig. 188.

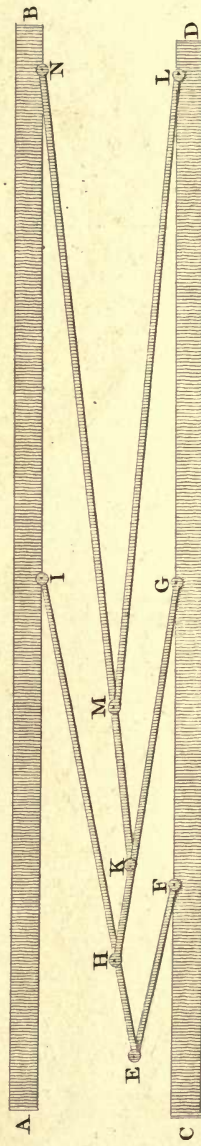


Fig. 189.

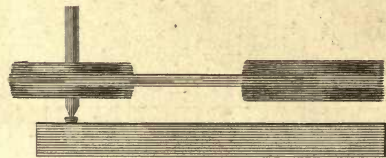


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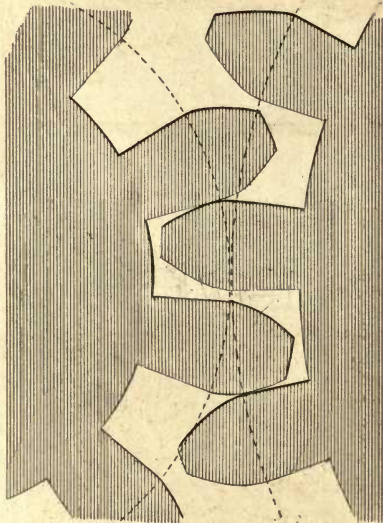


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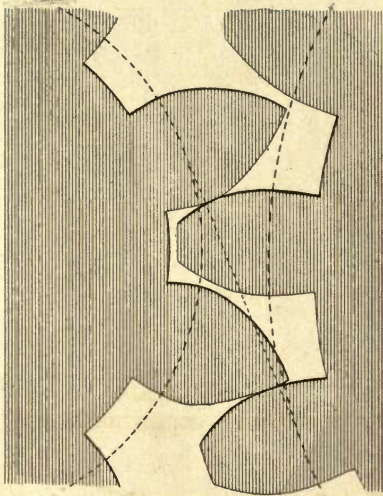


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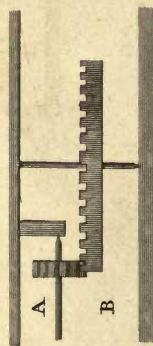


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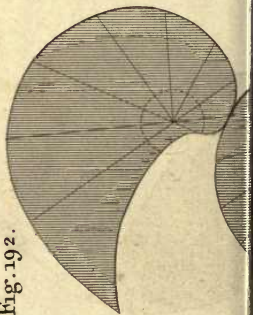


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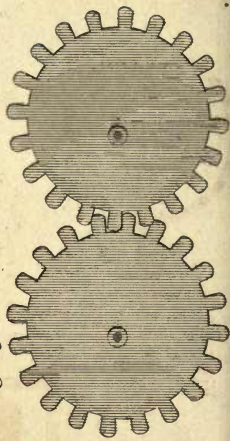


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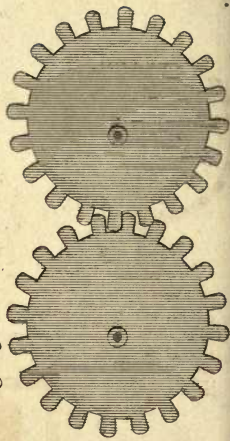




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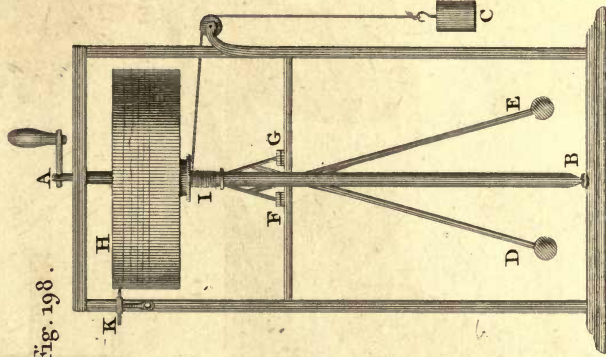


Fig. 197.

Fig. 198.

Fig. 199.

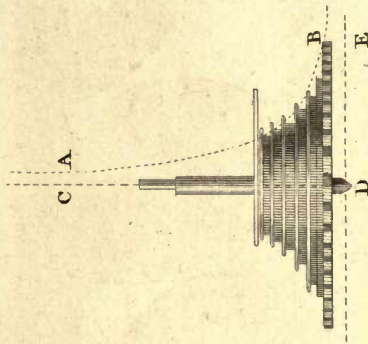


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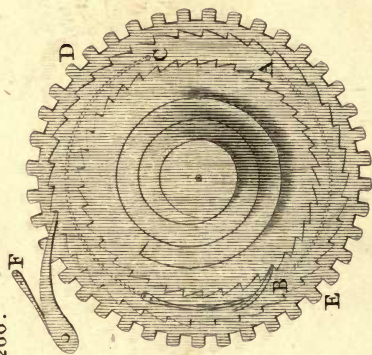


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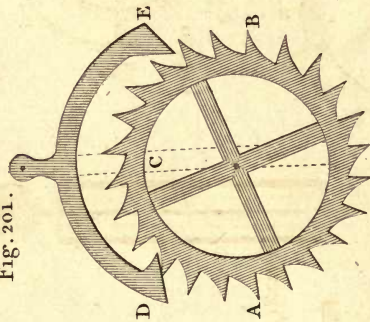


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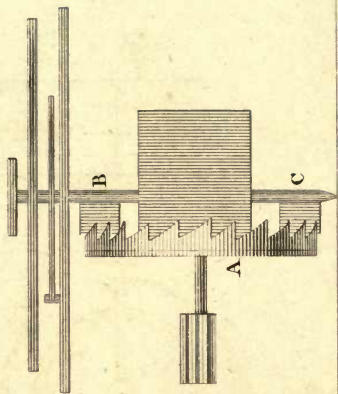


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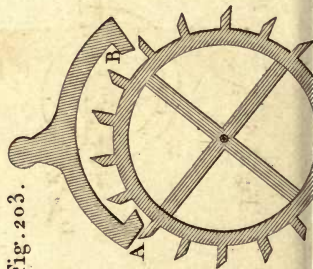


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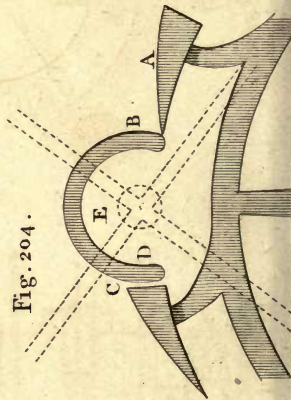
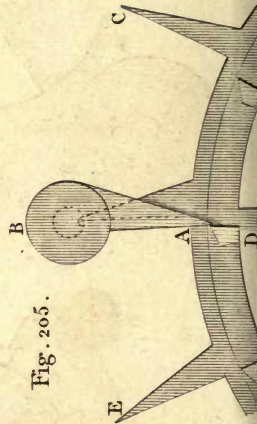


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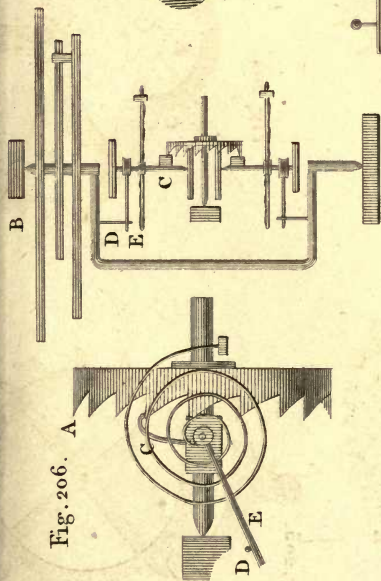


Fig. 206. A

Fig. 207.

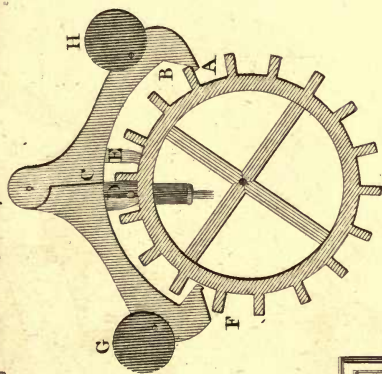


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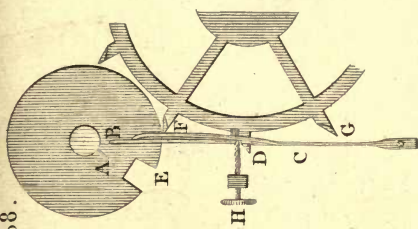


Fig. 210.



Fig. 209.

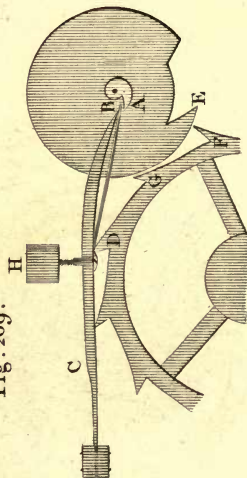


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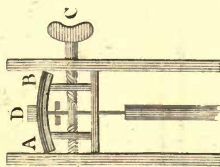


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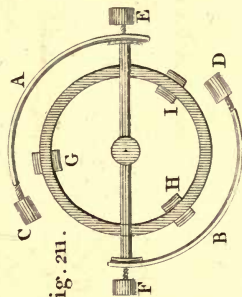


PLATE XVII.

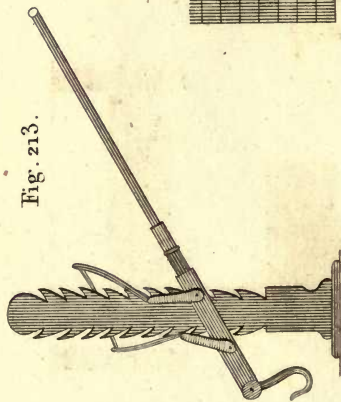


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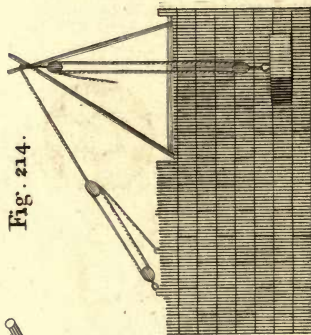


Fig. 214.

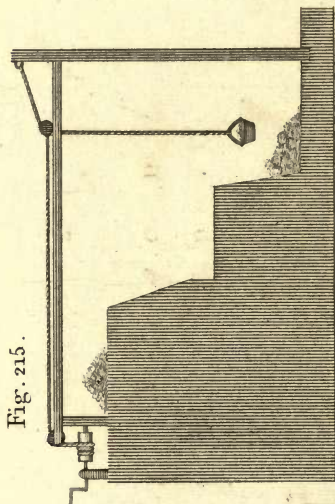


Fig. 215.

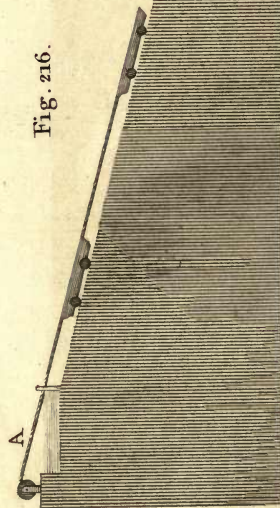


Fig. 216.

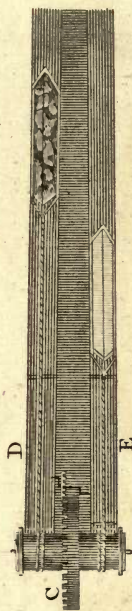


Fig. 217.

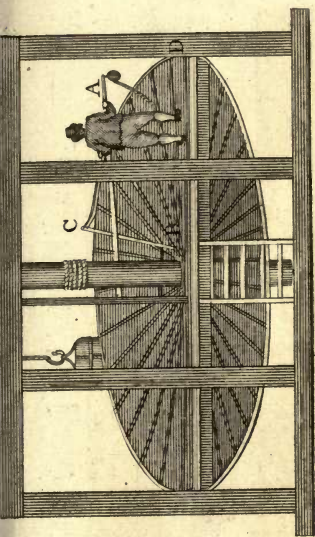
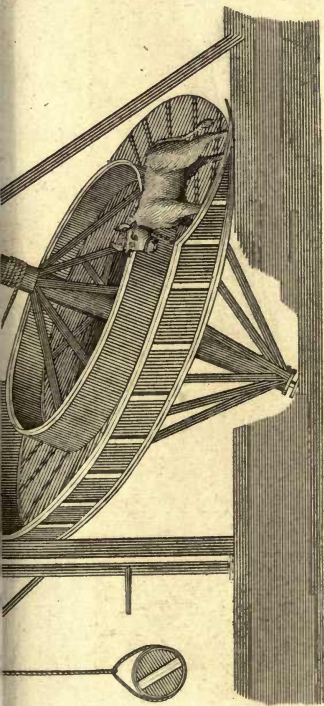


Fig. 219.



Fig. 220.

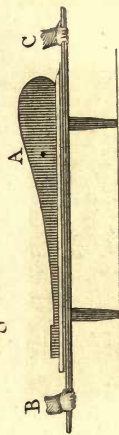


Fig. 221.

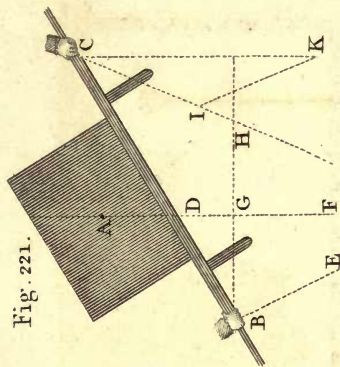


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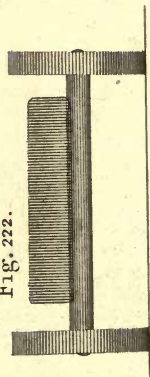


Fig. 223.

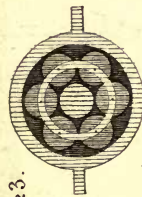




Fig. 224.

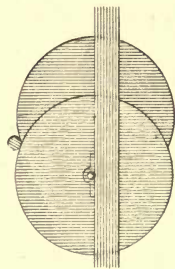


Fig. 225

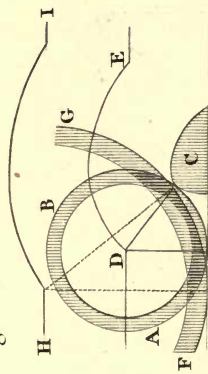


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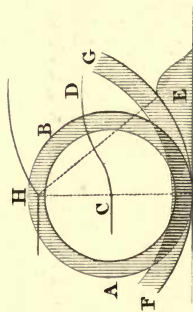


Fig. 227.

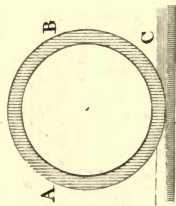


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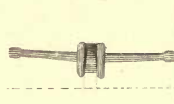


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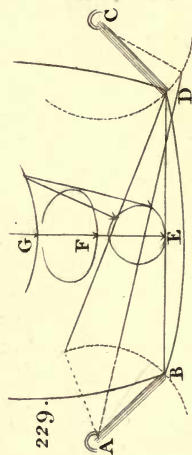


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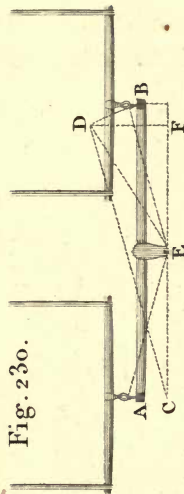


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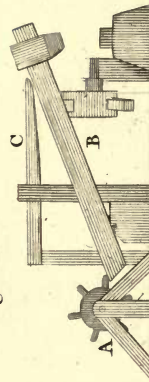


Fig. 232.

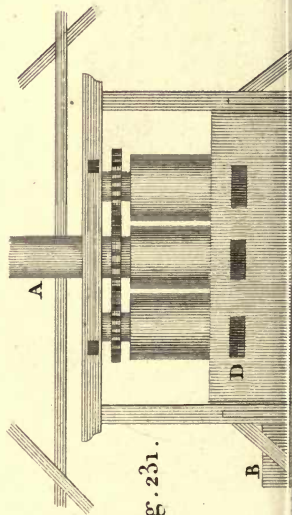


Fig. 231.

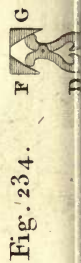


Fig. 234.

Fig. 235.

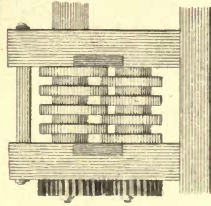


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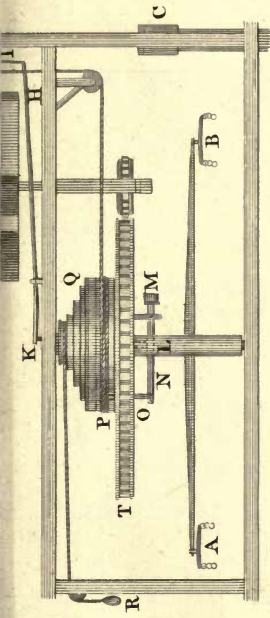
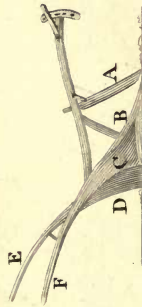


Fig. 237.

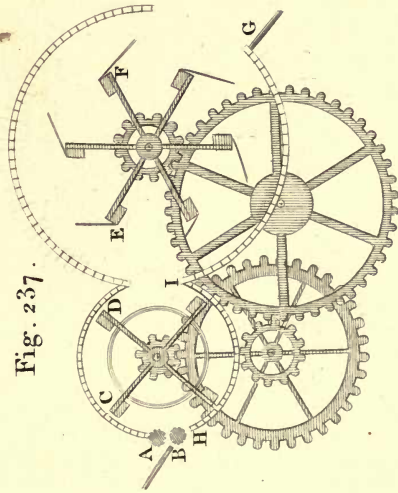
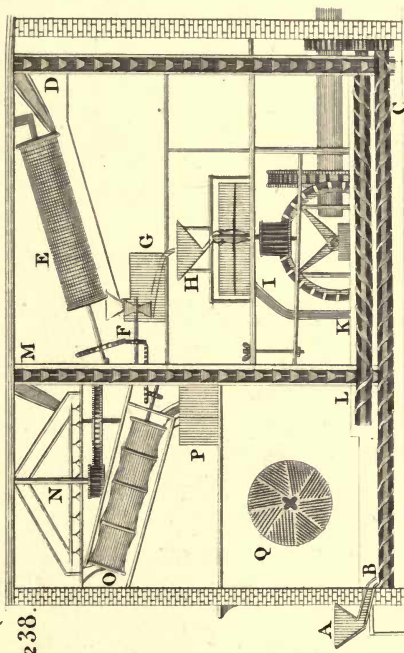


Fig. 238.



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PLATE XIX.

Fig. 239.

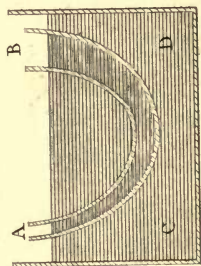


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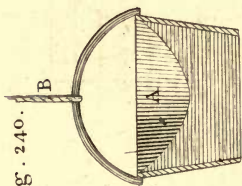


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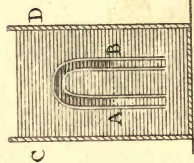


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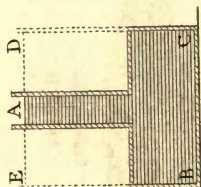


Fig. 243.

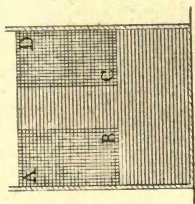


Fig. 244.

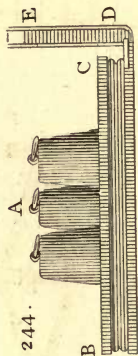
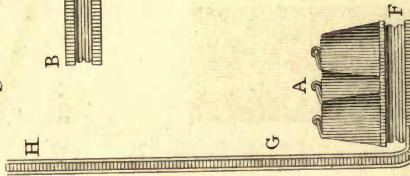


Fig. 245.

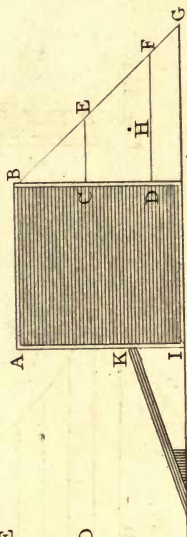


Fig. 246.

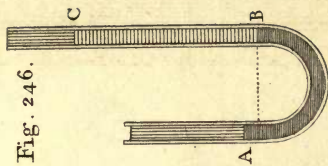


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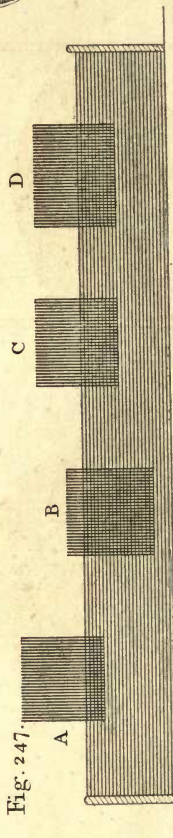


Fig. 251.



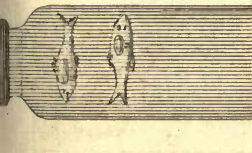


Fig. 249.

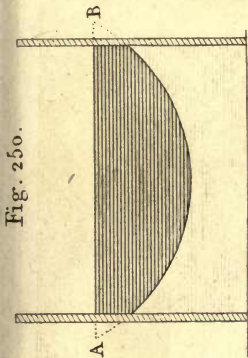
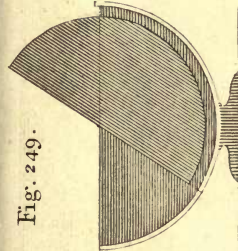


Fig. 250.

Fig. 252.

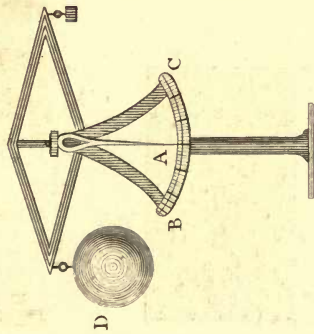


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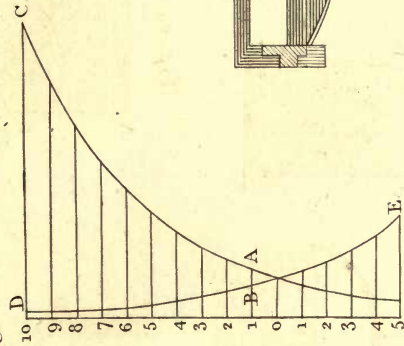


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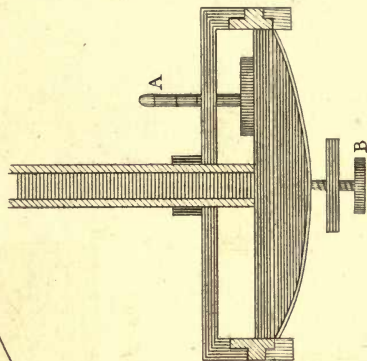


Fig. 255.

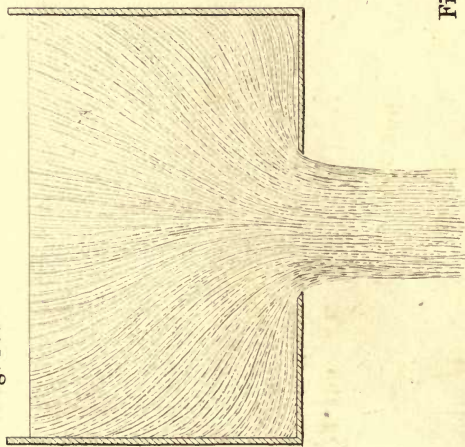


Fig. 256.

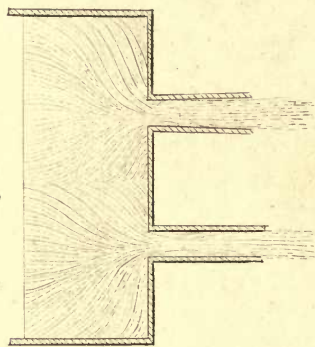


Fig. 257.

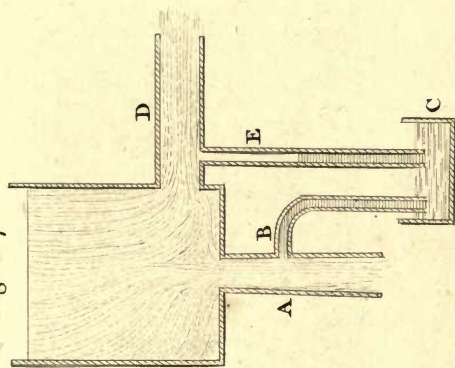


Fig. 258.

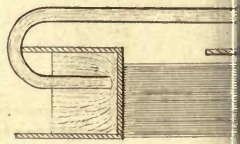


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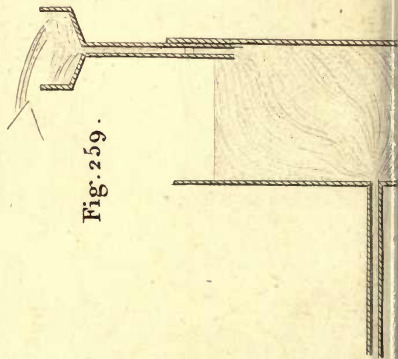


Fig. 260.



Fig. 263.

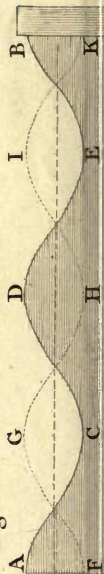


Fig. 261.

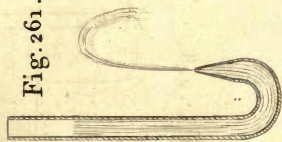


Fig. 262.

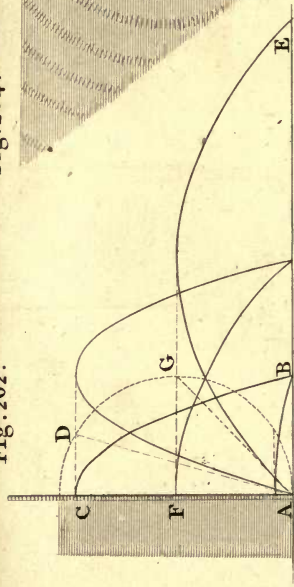


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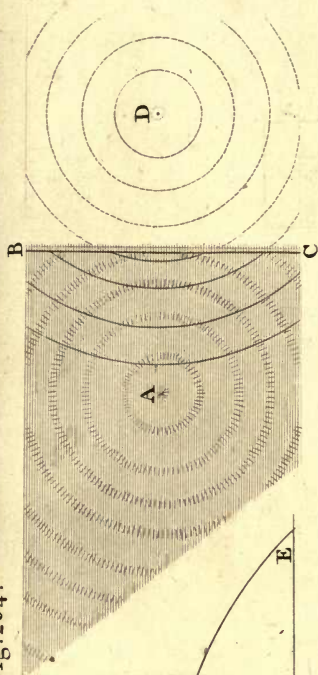


Fig. 266.

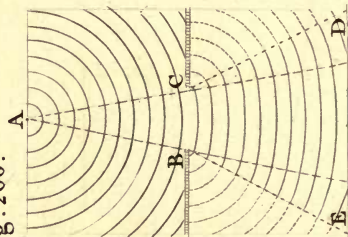


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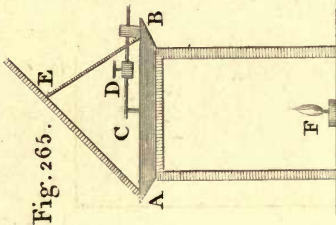
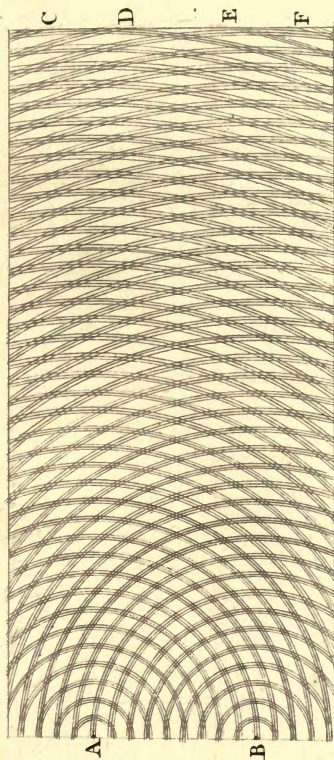


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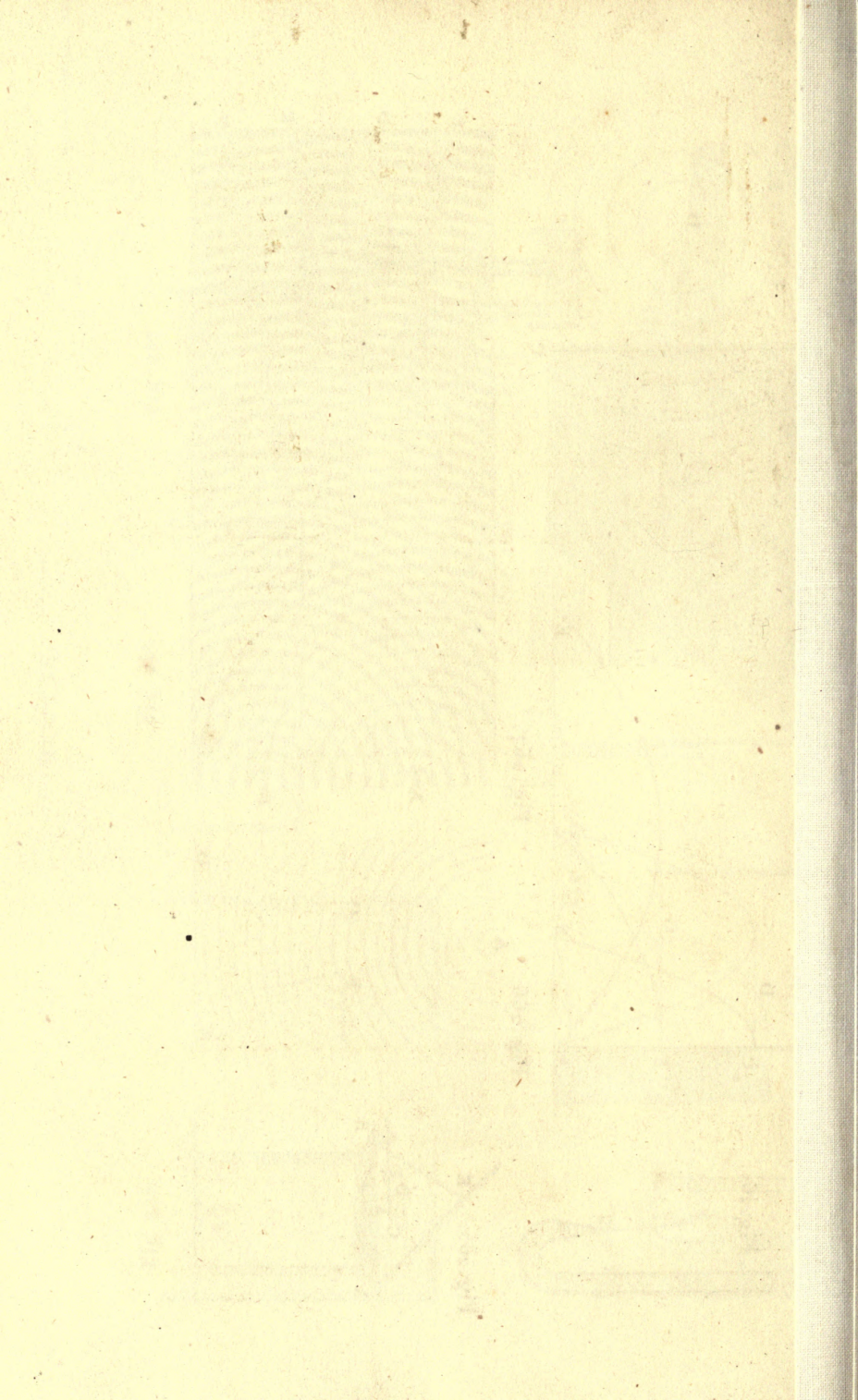


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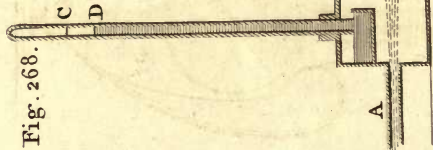


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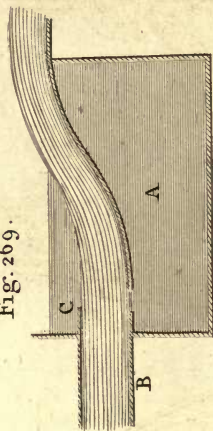


Fig. 270.



Fig. 271.

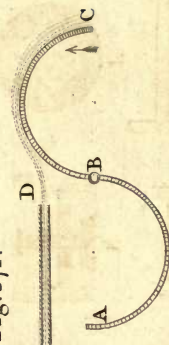


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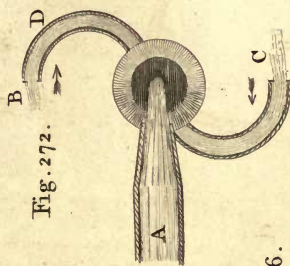


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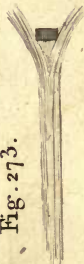


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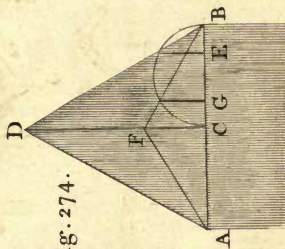


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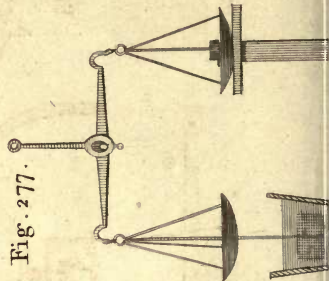


Fig. 276.



Fig. 275.

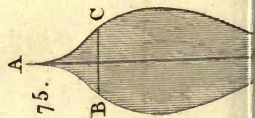


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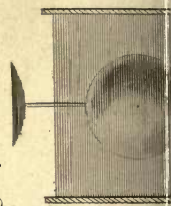


Fig. 279.



Fig. 281.



Fig. 282.



Fig. 280.

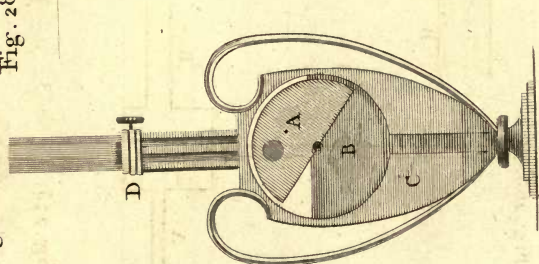


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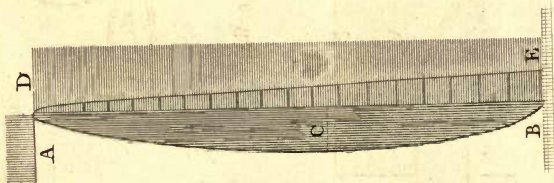


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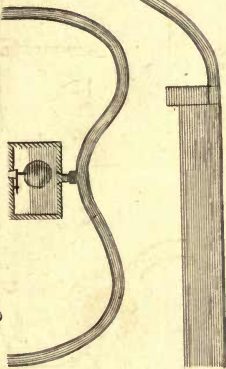


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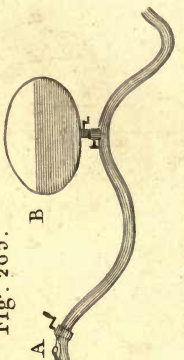


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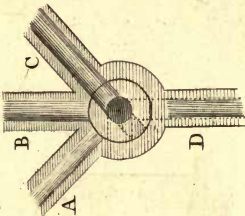


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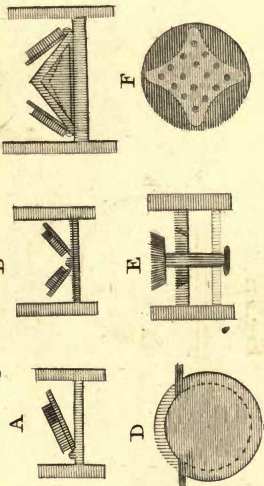


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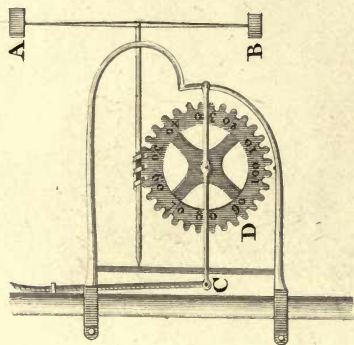


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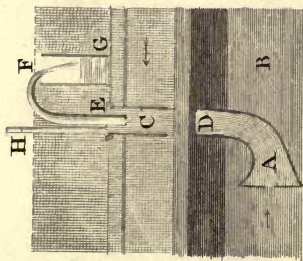


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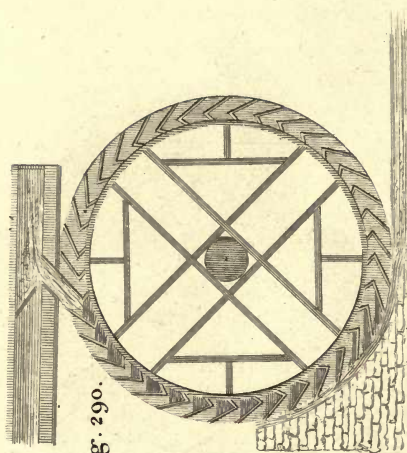


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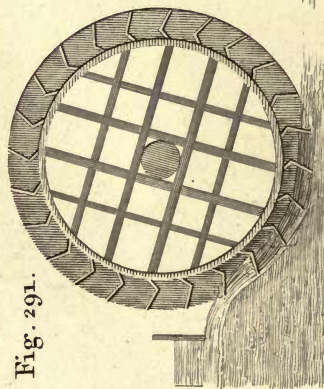


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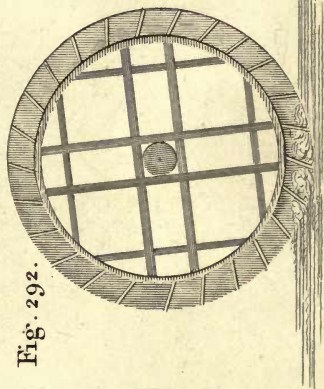


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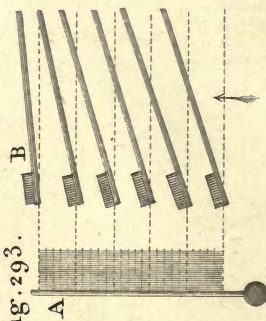


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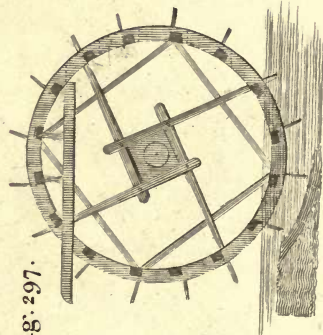
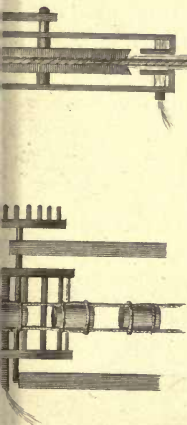
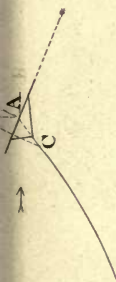


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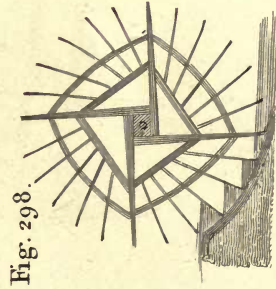


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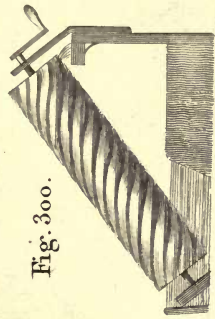


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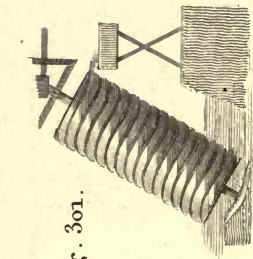


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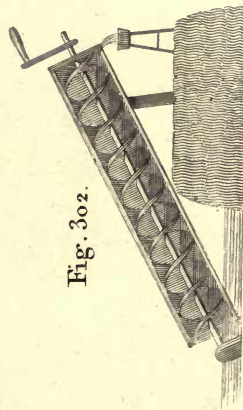


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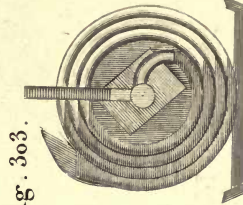
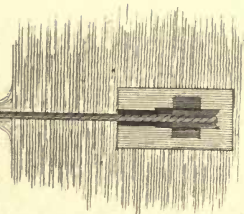


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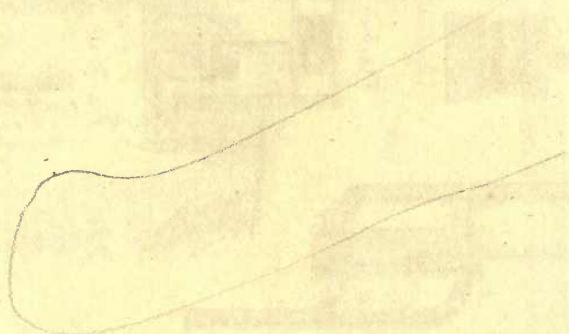


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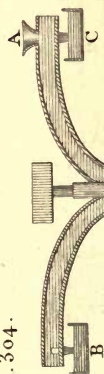


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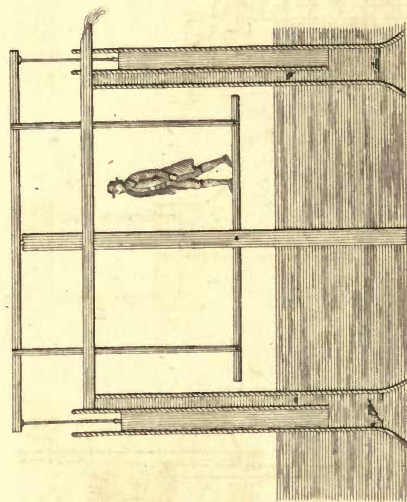


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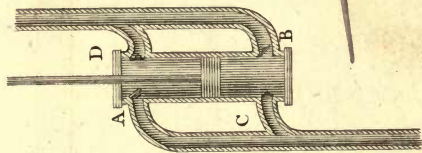


Fig. 307.



Fig. 308.

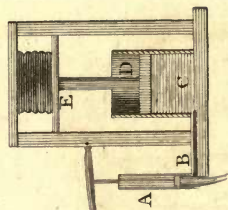


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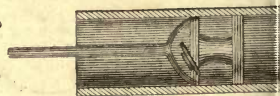


Fig. 310.



Fig. 311.

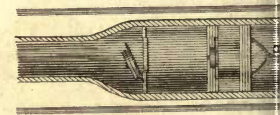


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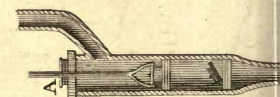


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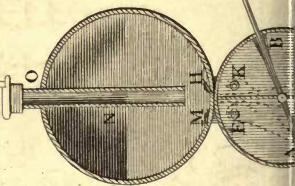


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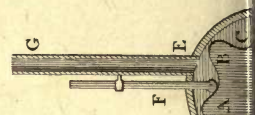




Fig. 316.



Fig. 317.

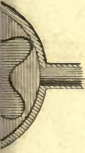


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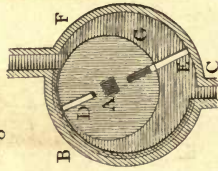


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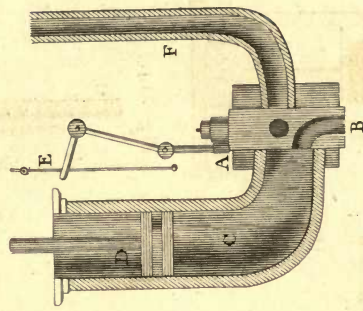


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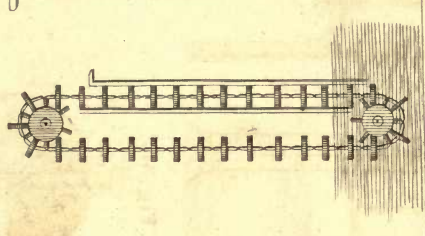


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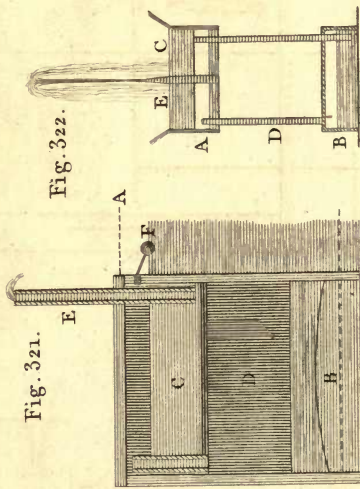


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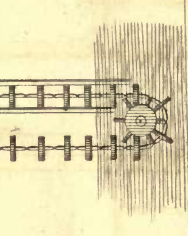


Fig. 322.



Fig. 323.

PLATE XXIV.

Fig. 324.

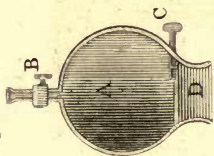


Fig. 327.



Fig. 325.

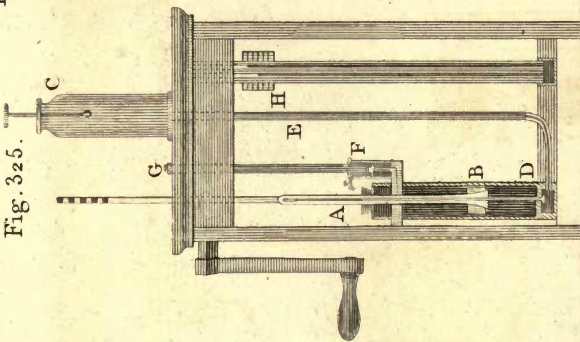


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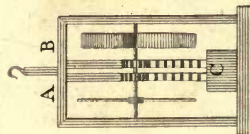


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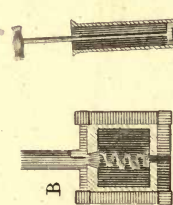


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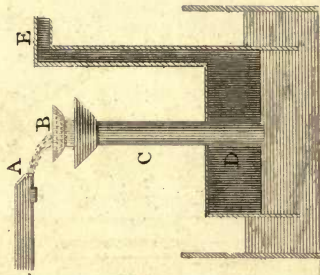


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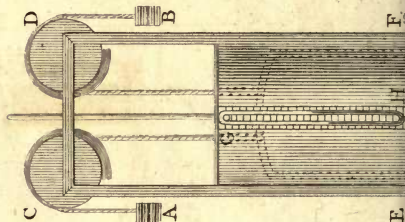


Fig. 328.



Fig. 330.

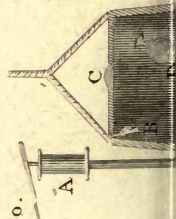


Fig. 331.



Fig. 334.





Fig. 335.

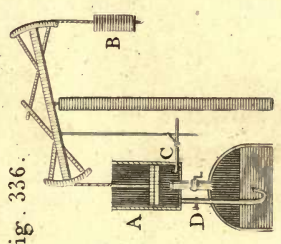


Fig. 336.



Fig. 337.

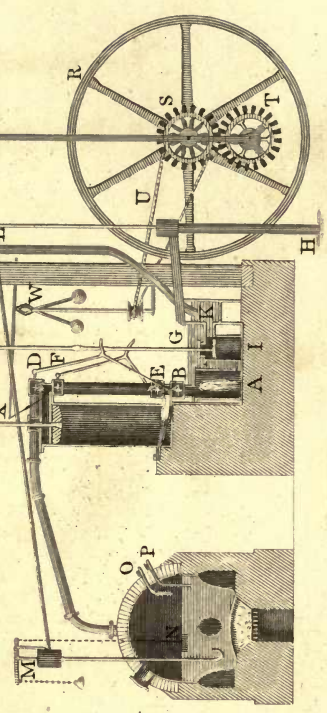


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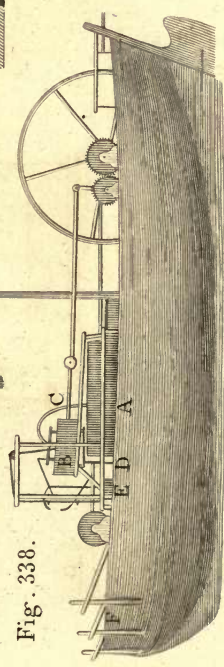
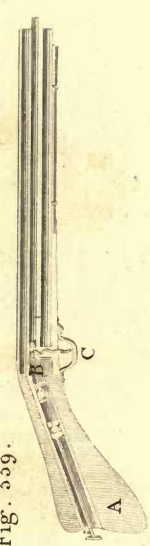


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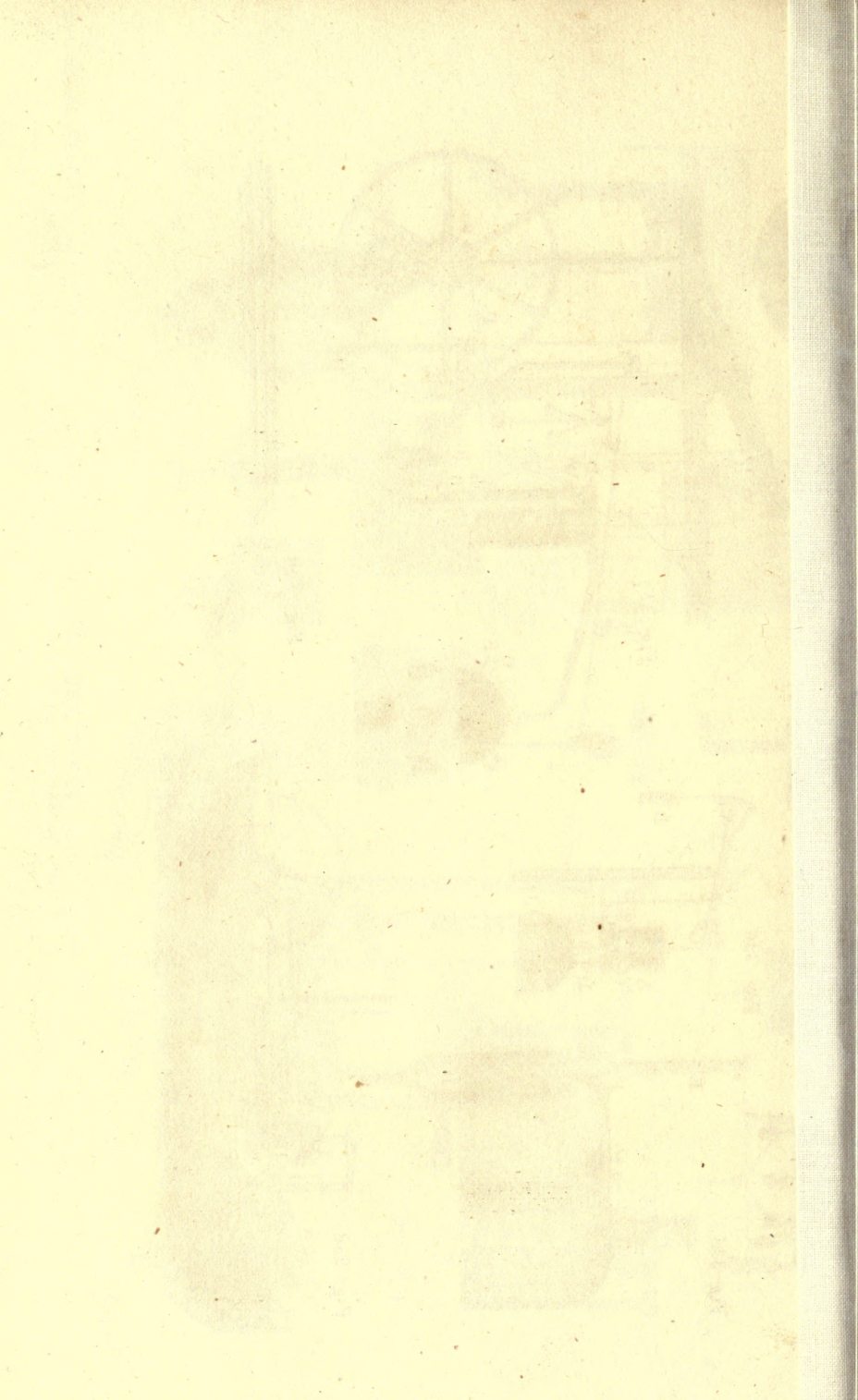


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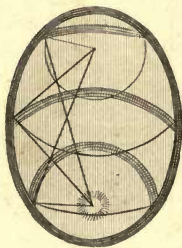


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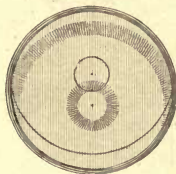


Fig. 342.



Fig. 343.

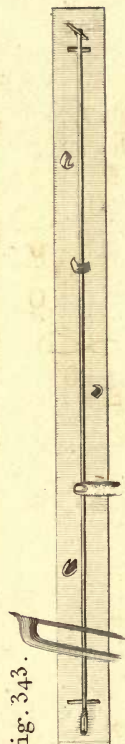
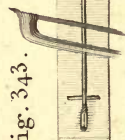


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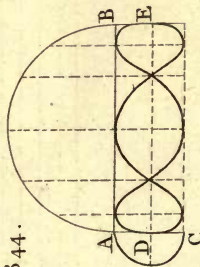


Fig. 345.



Fig. 347.

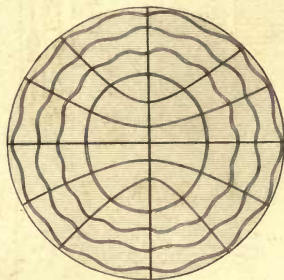


Fig. 348.



Fig. 346.

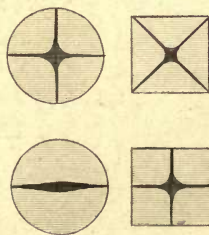


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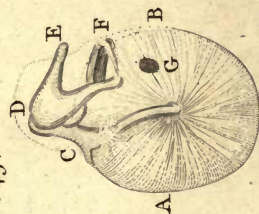


Fig. 352.



Fig. 351.





Fig. 353.

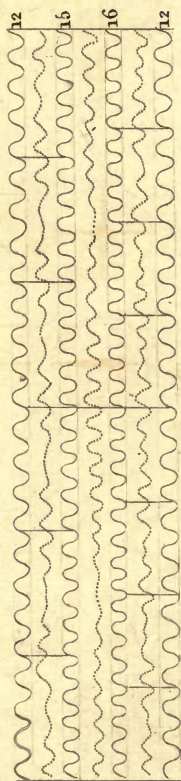


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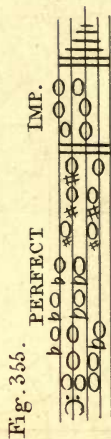
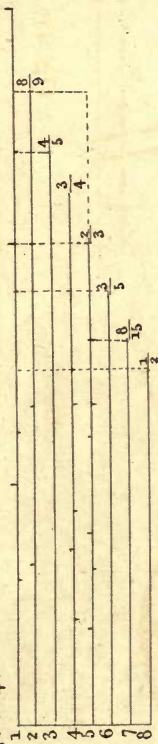


Fig. 355.

PERFECT

IMP.



Fig. 356.

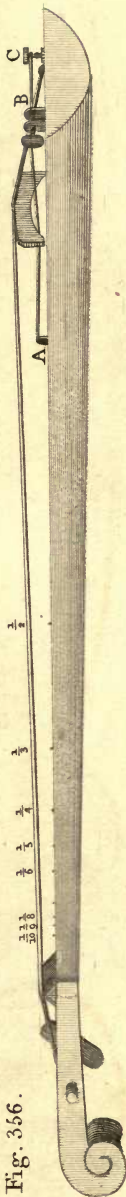


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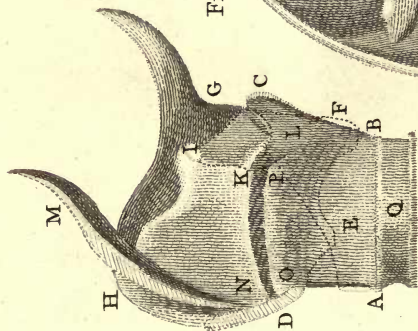


Fig. 358.

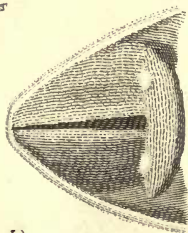


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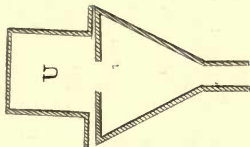
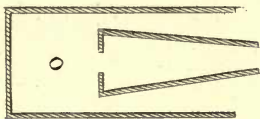
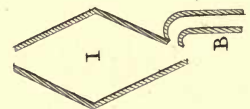
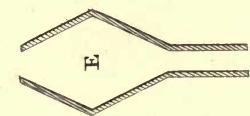
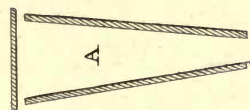


Fig. 364.



Fig. 365.



Fig. 363.

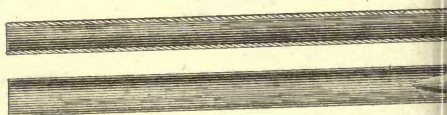


Fig. 367.



Fig. 368.



Fig. 360.

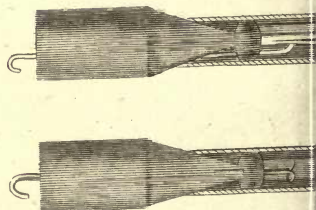


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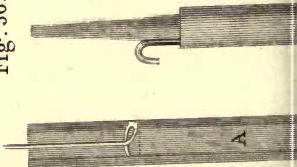


Fig. 362.



Fig. 366.



Fig. 369.

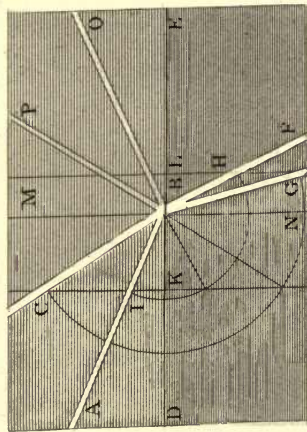


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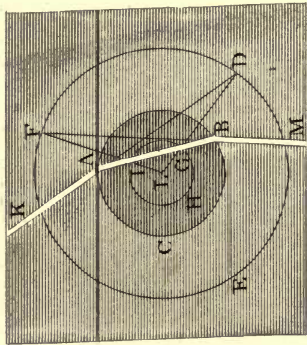


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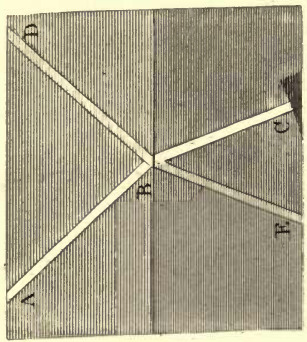


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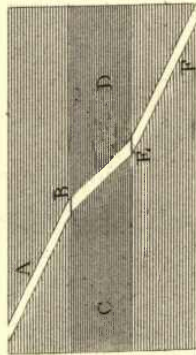


Fig. 373.

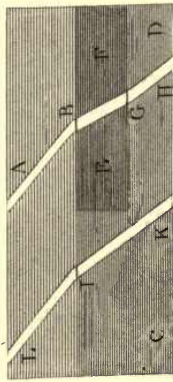
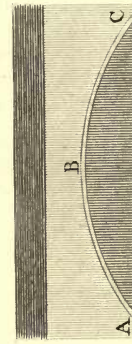


Fig. 374.



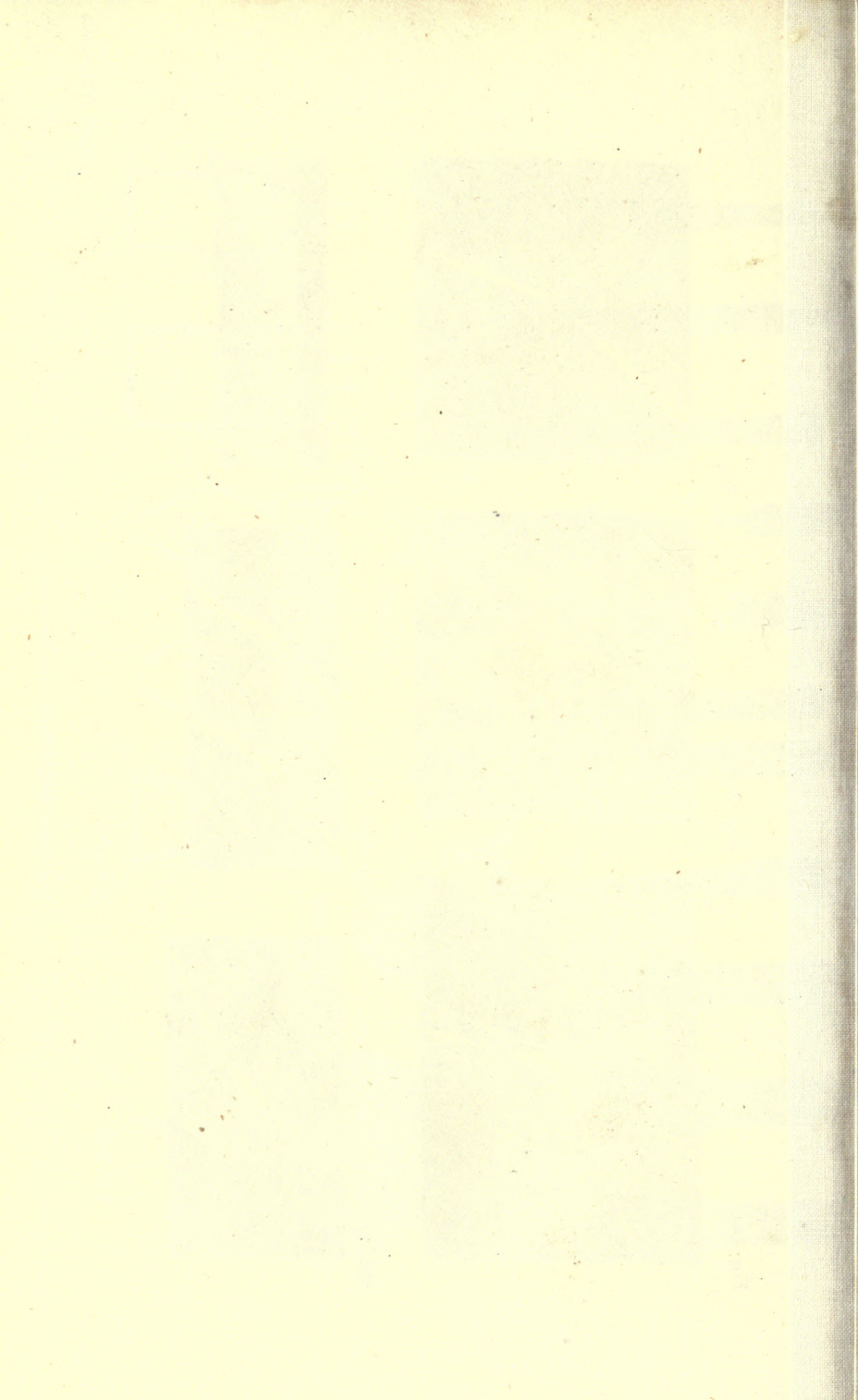


Fig. 375.



Fig. 378.



Fig. 379.



Fig. 382.

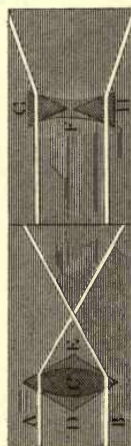


Fig. 384.

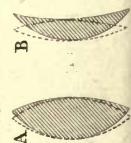


Fig. 385.



Fig. 386.



Fig. 377.

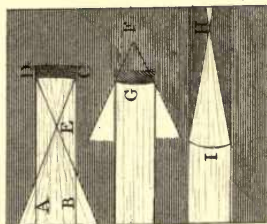


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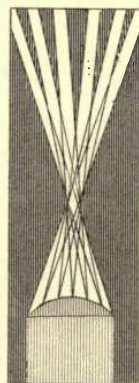


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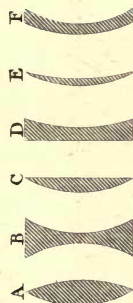


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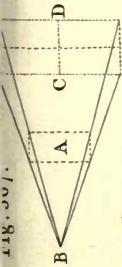


Fig. 388.

Fig. 390.



Fig. 391.

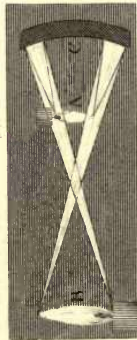


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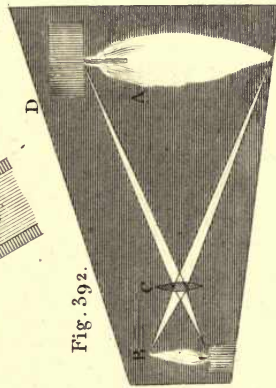


Fig. 393.



Fig. 394.



Fig. 395.

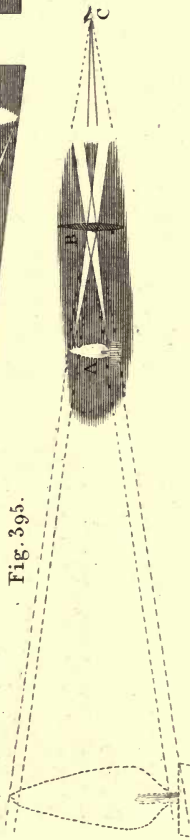


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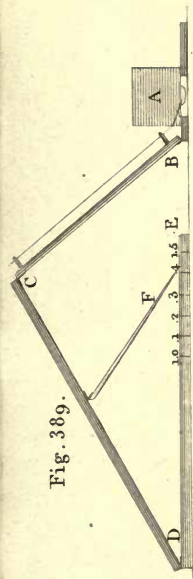
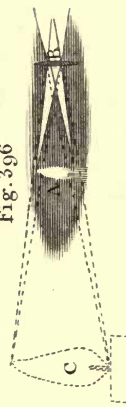
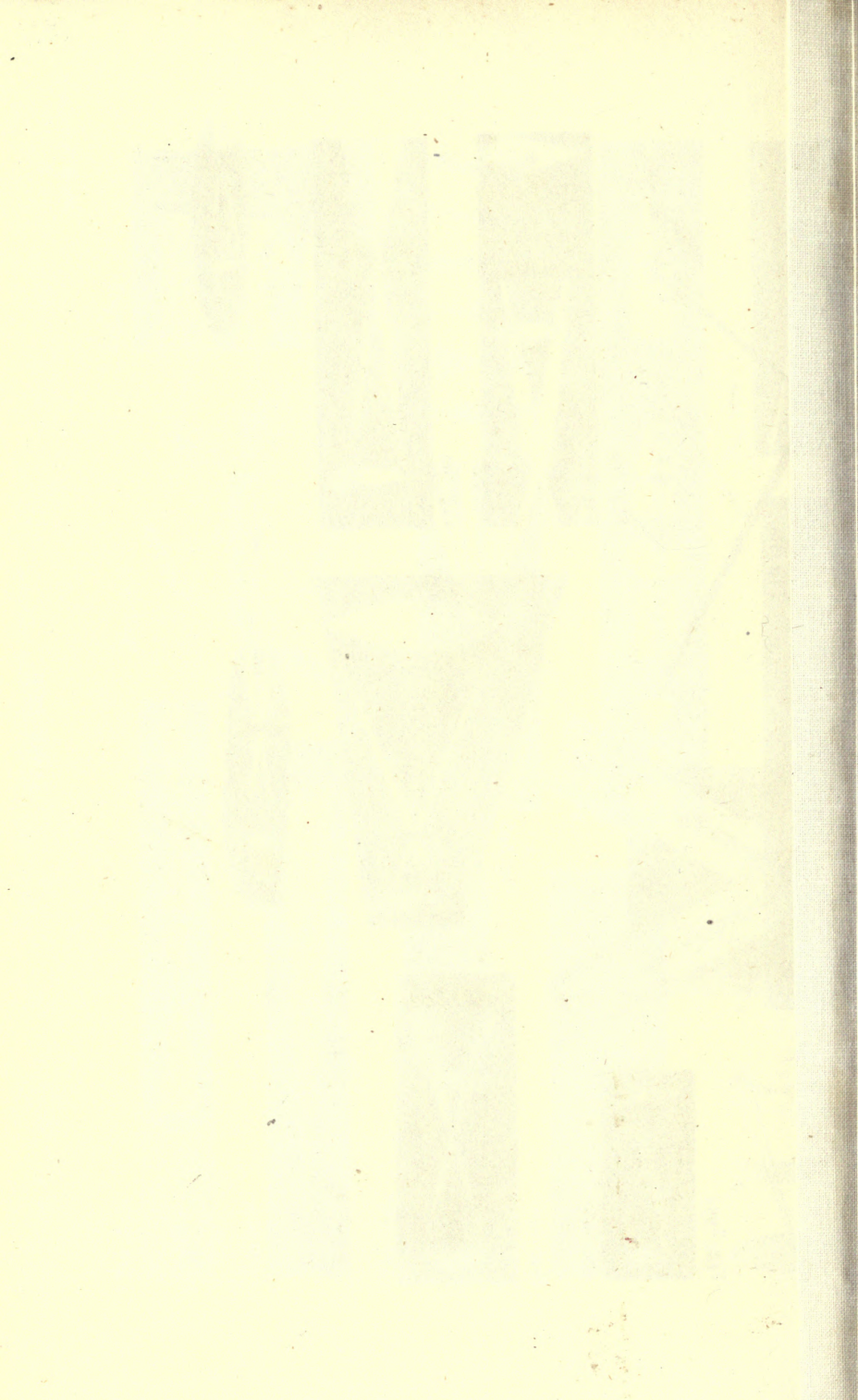


Fig. 389.



29 Follows 42

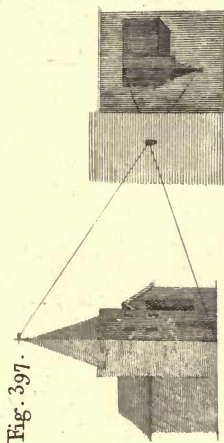


Fig. 397.

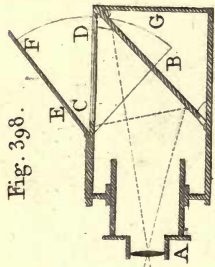


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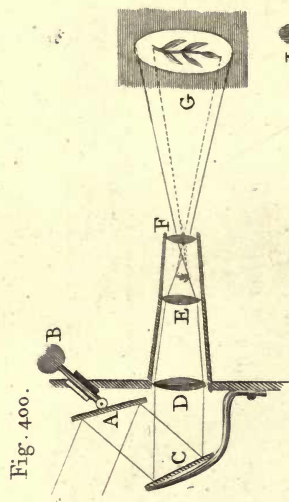


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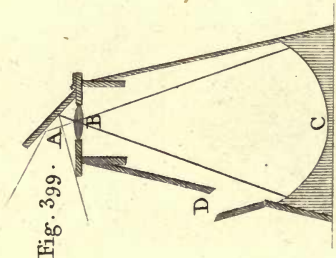


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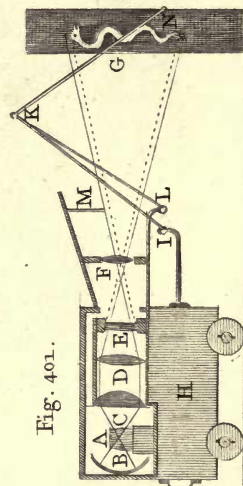


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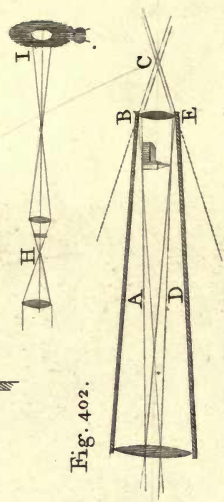


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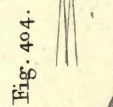


Fig. 404.

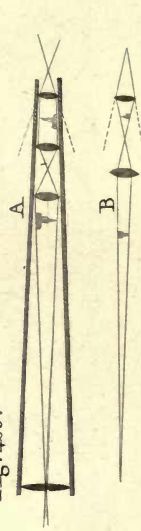


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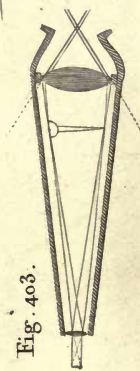


Fig. 403.

Fig. 407.

Fig. 408.



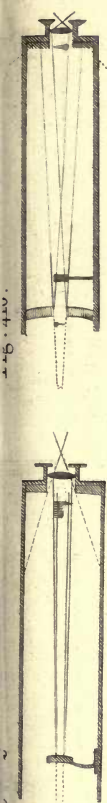


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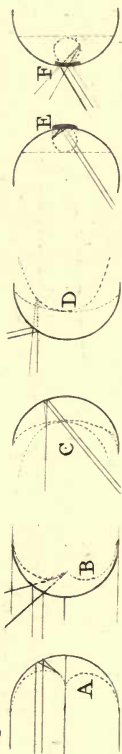


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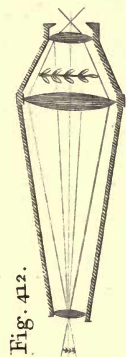
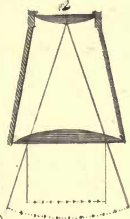


Fig. 412.

Fig. 414.



Fig. 415.

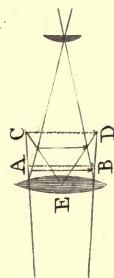
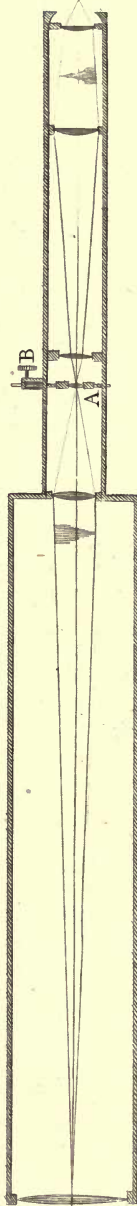
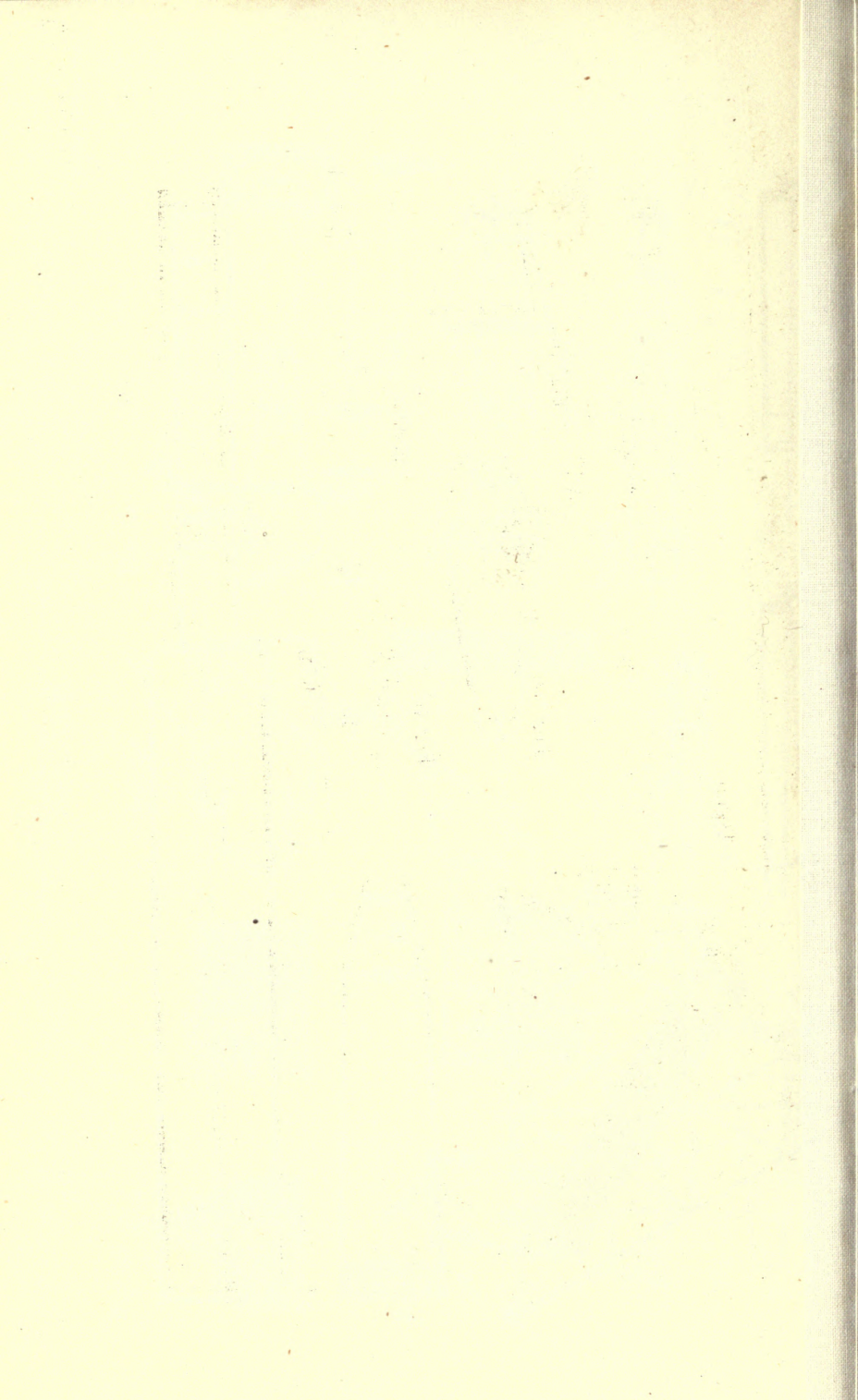


Fig. 417.



Fig. 416.





29+30

Follow 41

Fig. 454.

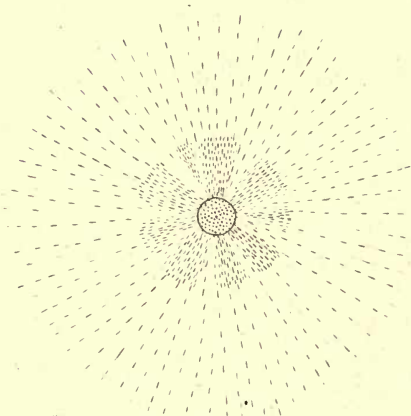


Fig. 455.



Fig. 456.

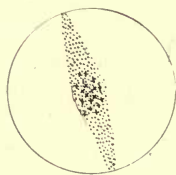


Fig. 453.



Fig. 457.

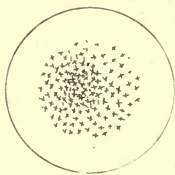


Fig. 458.

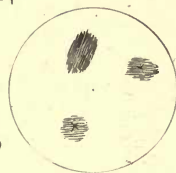


Fig. 460.

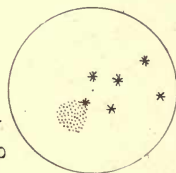


Fig. 461.

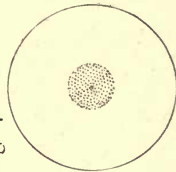


Fig. 462.

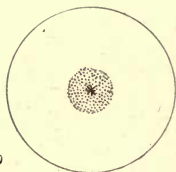


Fig. 463.

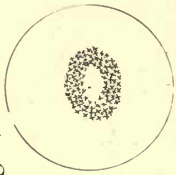


Fig. 465.



Fig. 464.



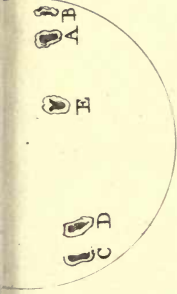
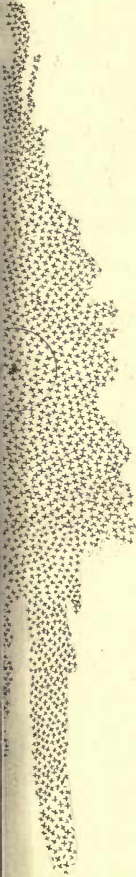


Fig. 466.

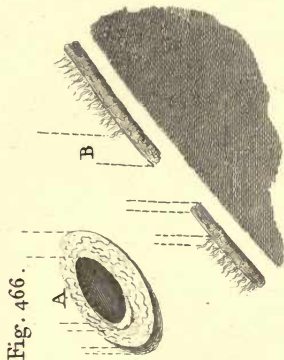


Fig. 467.

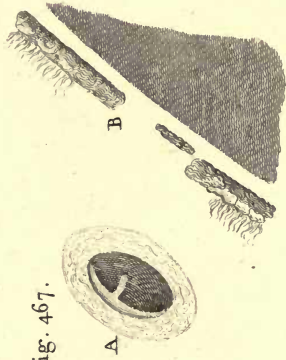


Fig. 470.

*
Aldebaran
*
Pleiades

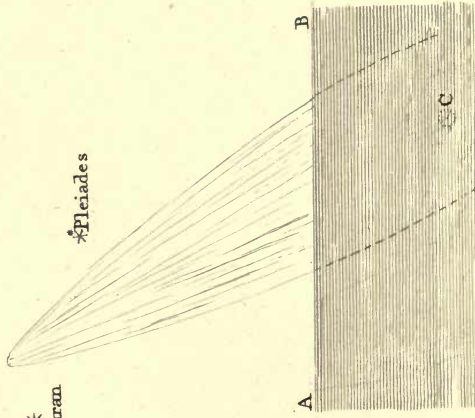


Fig. 469.

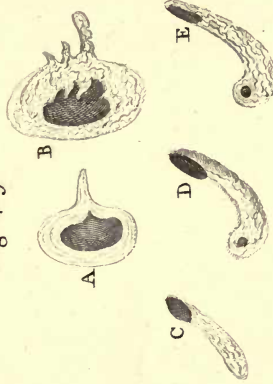


Fig. 468.

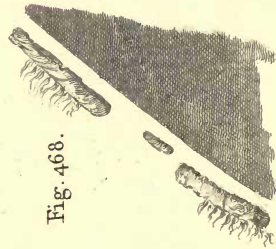


Fig. 471.

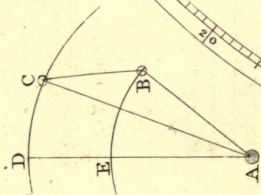
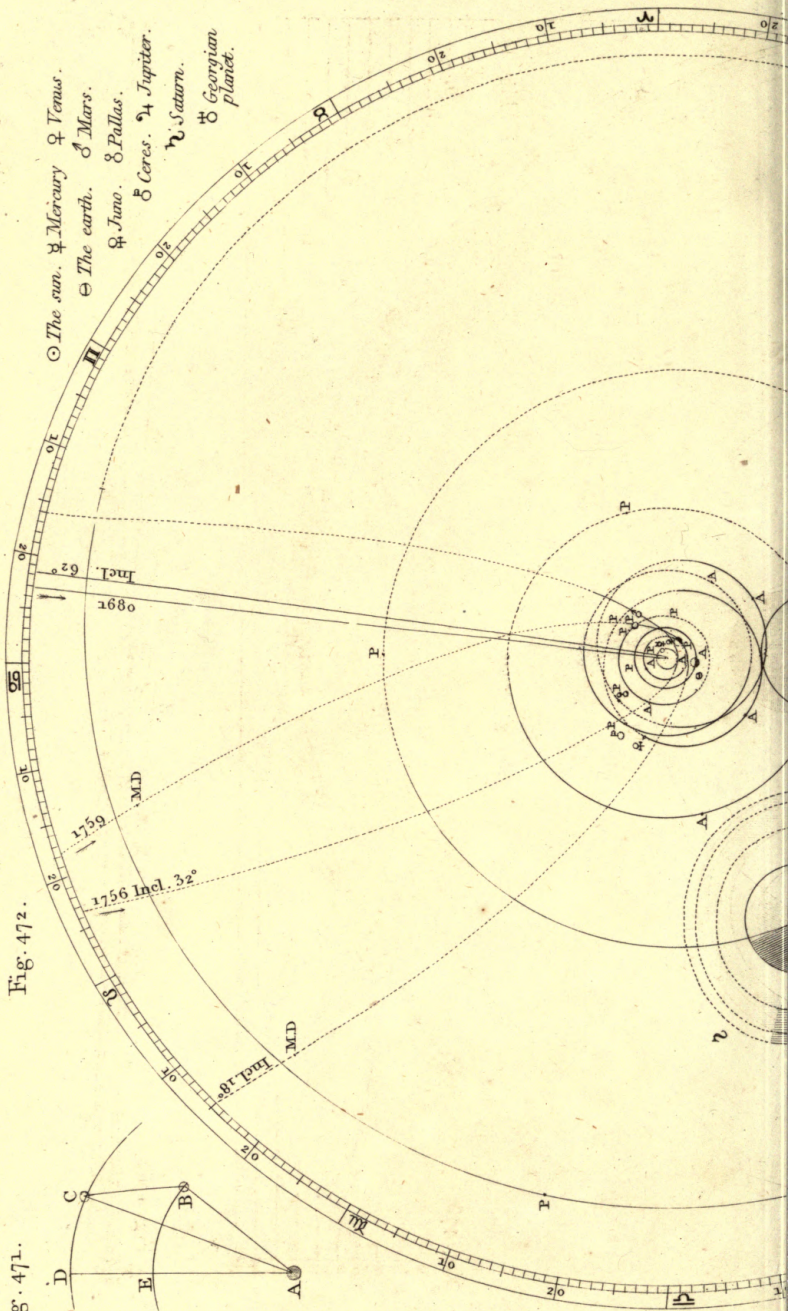


Fig. 472.



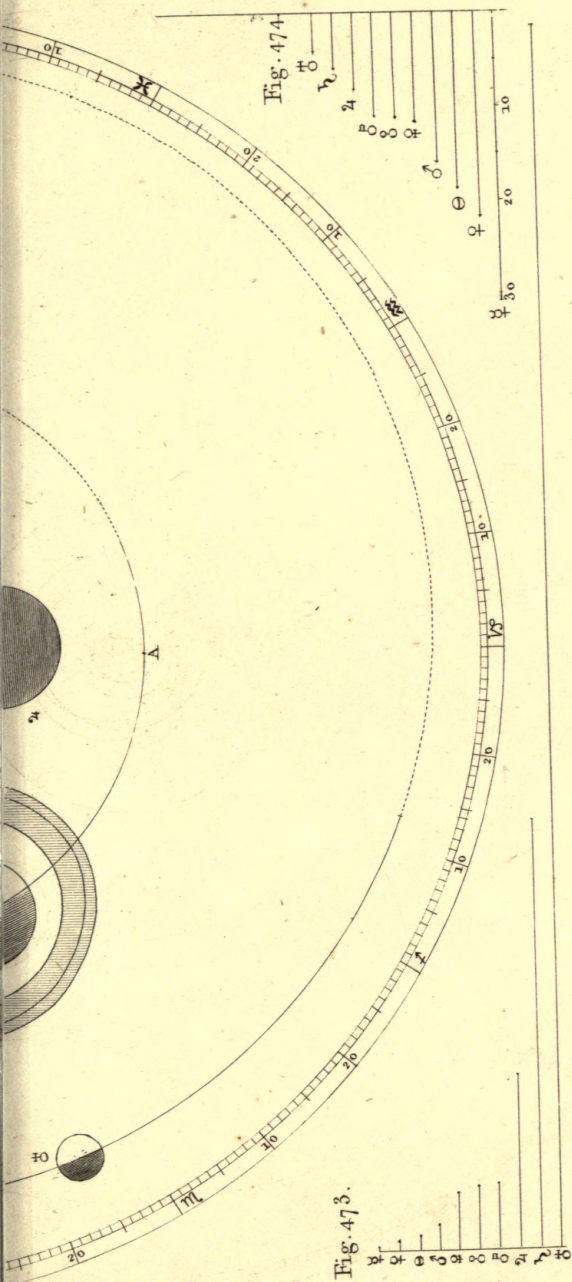


Fig. 474.

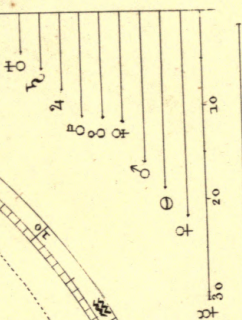


Fig. 476.



Fig. 477.

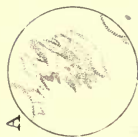


Fig. 478.

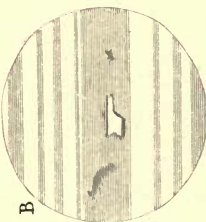
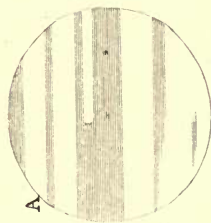


Fig. 479.

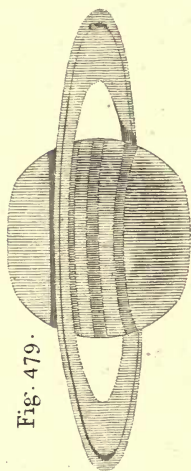
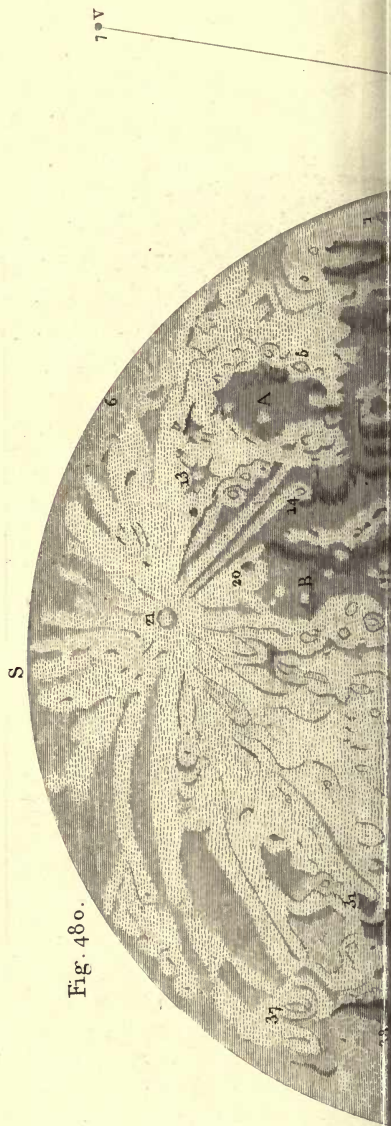


Fig. 480.



79V

Fig. 481.



Fig. 484.

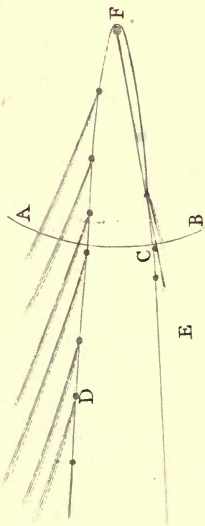


Fig. 485.



Fig. 482.

Fig. 483.

Fig. 486.

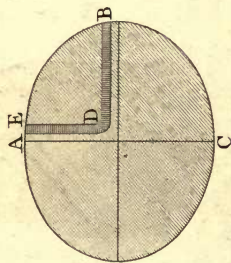


Fig. 488.

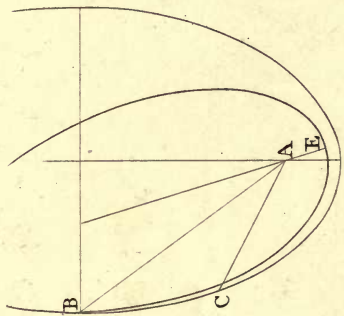


Fig. 489.

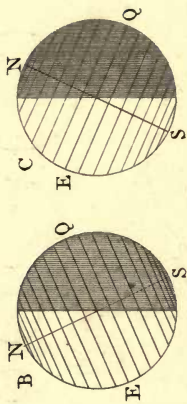
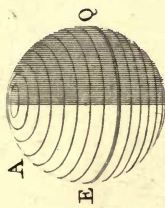


Fig. 487.

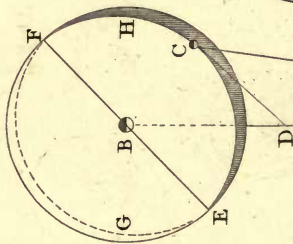


Fig. 491.



Fig. 492.

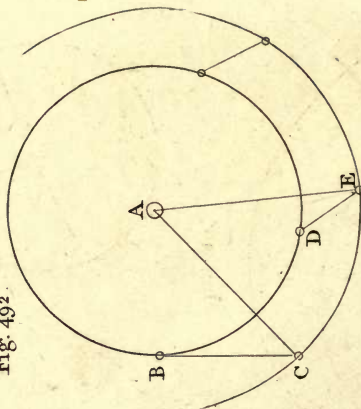


Fig. 490.

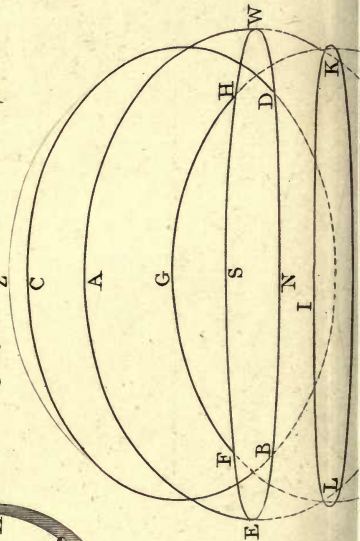


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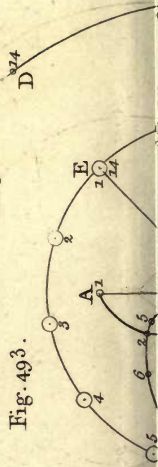


Fig. 494.

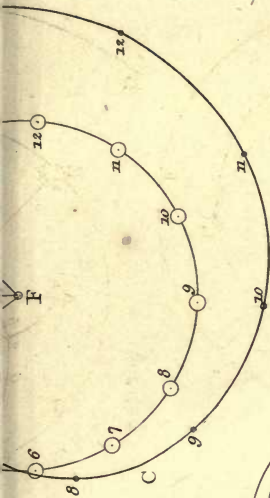
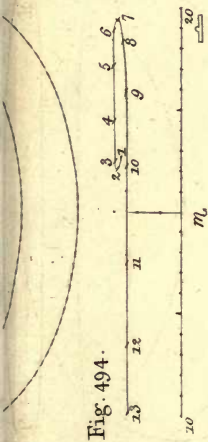


Fig. 495.

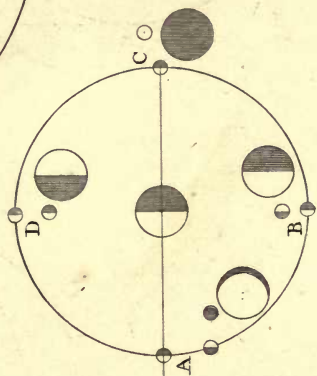
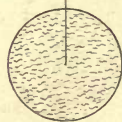


Fig. 496.



Fig. 499.

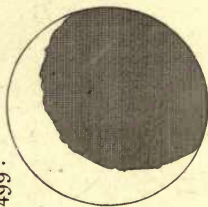


Fig. 500.

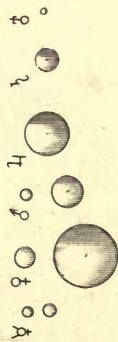


Fig. 501.



Fig. 498.

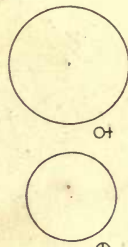


Fig. 497.

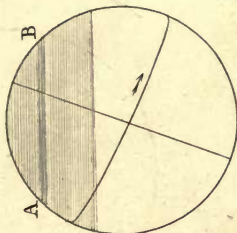


Fig. 502.

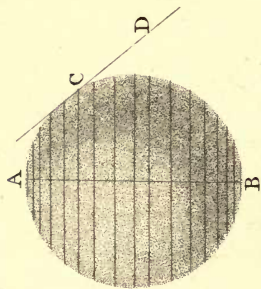


Fig. 503.

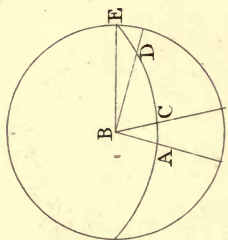


Fig. 504.

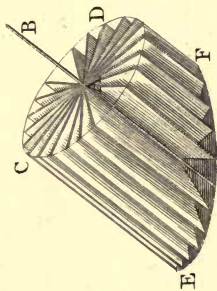


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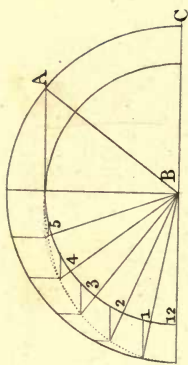


Fig. 506.

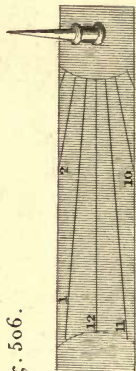


Fig. 507.

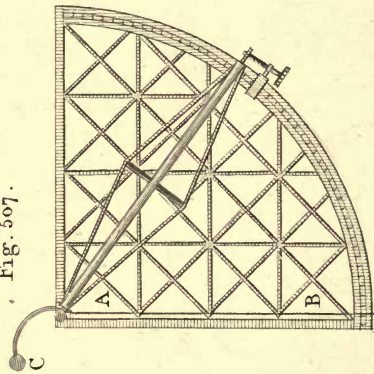


Fig. 508.

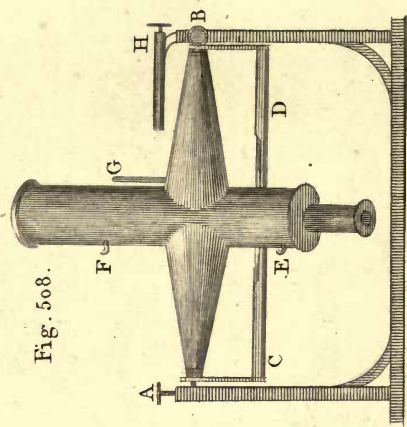


Fig. 509.

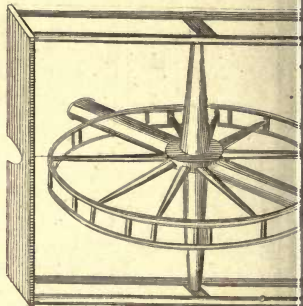


Fig. 512.



Fig. 511.





Fig. 510.

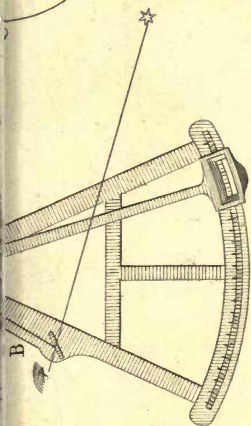


Fig. 513.

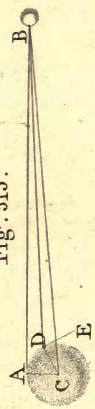


Fig. 514.



Fig. 515.

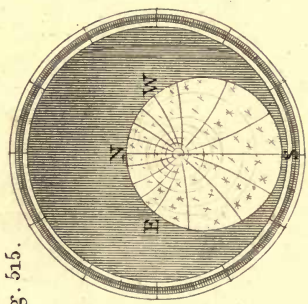


Fig. 516.

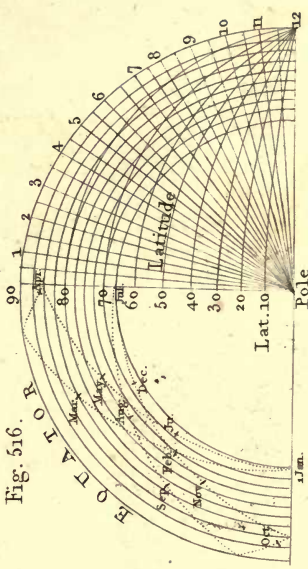
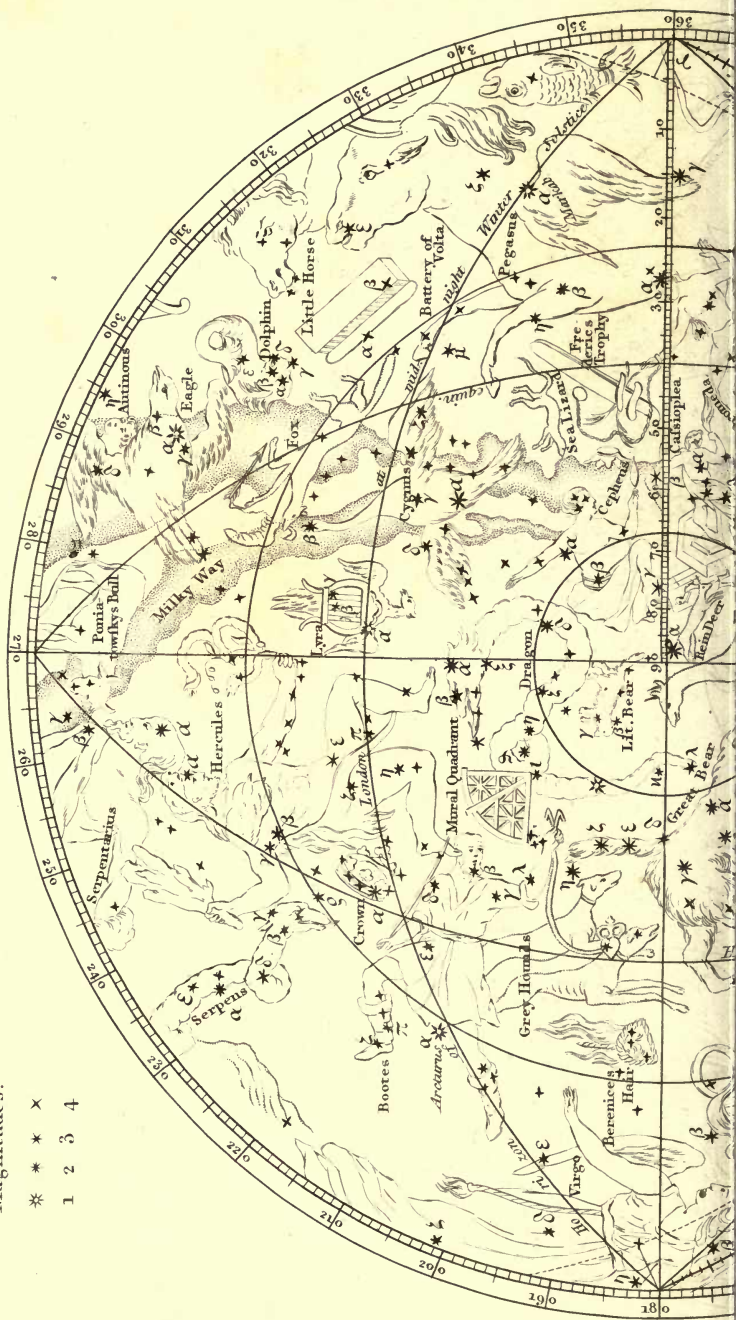
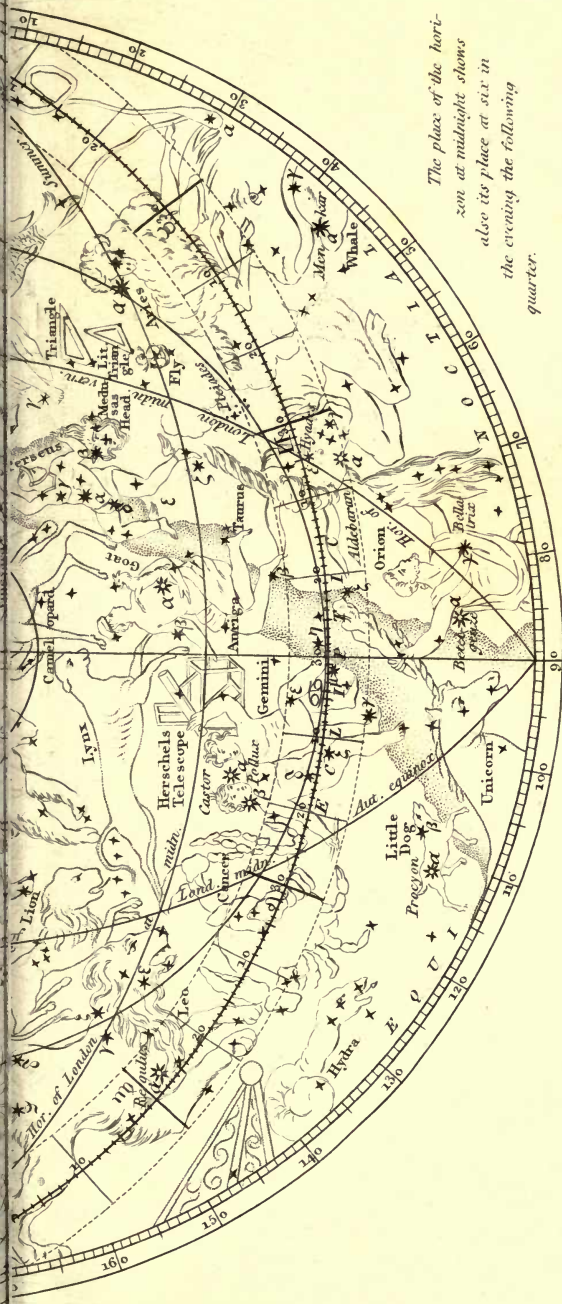


PLATE XXVI. Fig. 517.

Magnitudes.

* * * ×
1 2 3 4



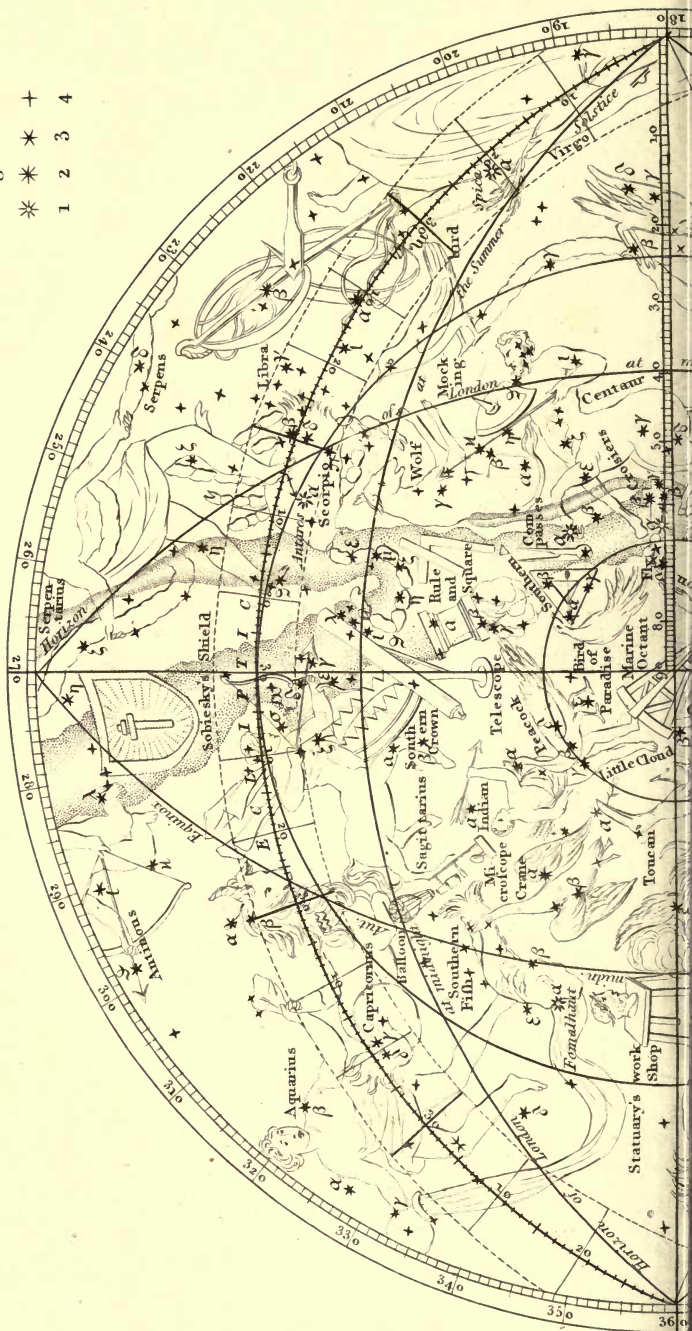


The place of the horizon at midnight shows also its place at six in the evening the following quarter.

PLATE XXXVII. Fig. 518.

Magnitudes.

* * * +
1 2 3 4



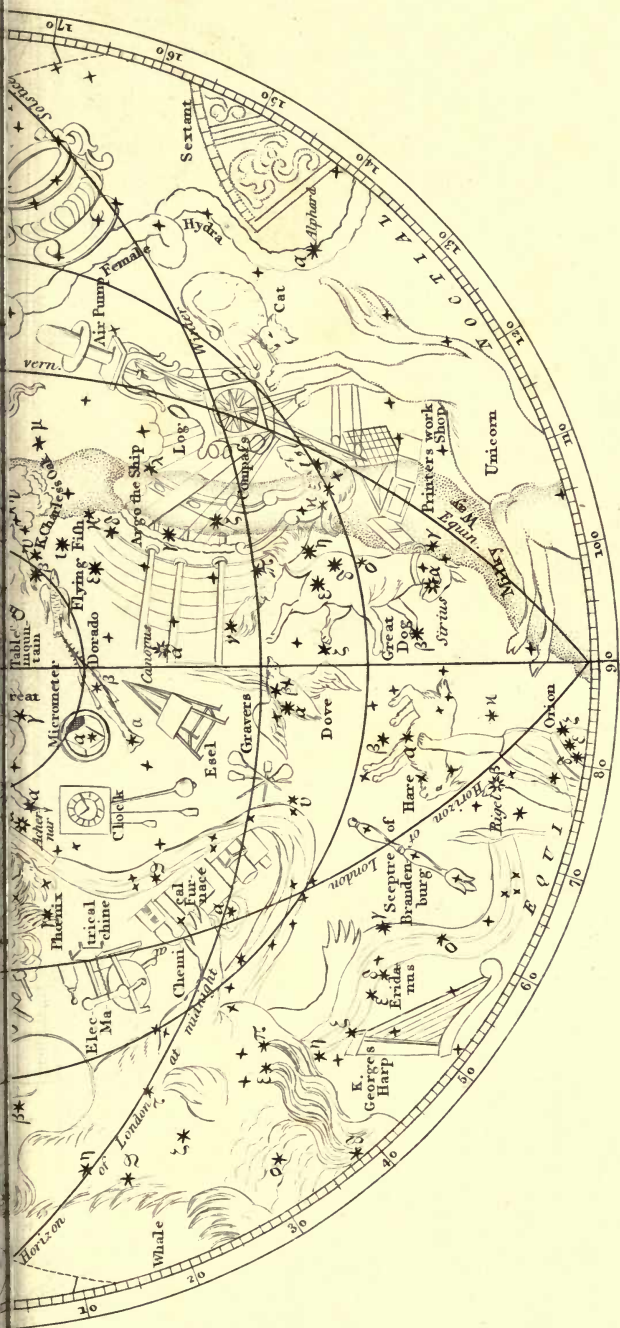
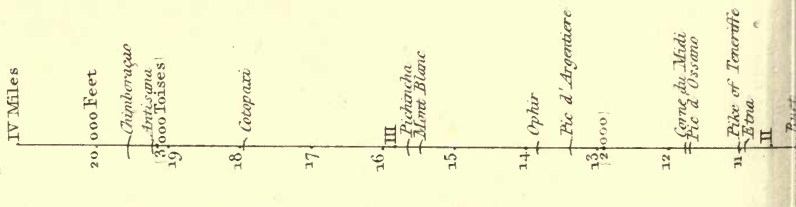


Fig. 519.



9. *Pic du Midi*
Monte Cenis
Carigna
Condor Abyss.
Monte Vetro
 8. *Pic de los Reyes*
 7. *Mont d'or*
 6. *Mont Cenis post house*
Mole
Mount Jura
 5. *Puy de Dome*
Pic Ruivo Mad
Hecla
 4. *Ben Nevis*
Wharfedale
Engleborough
Pesquay
Widdall
Table mount
 3. *Chamney inn*
Skiddaw
Ben Lomond
Saddleback
 2. *Aosta*
 1. *Lake of Geneva*
Arbury seat
Chandbury ring duns
St. Peter's from the ground
 0. *Sea*
Caspian Sea

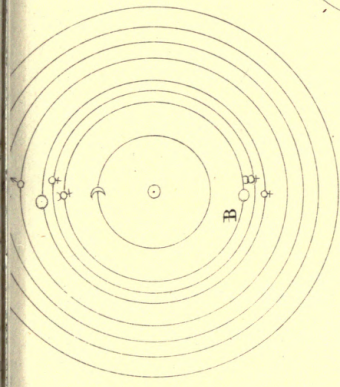


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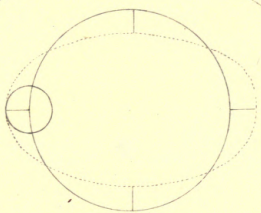


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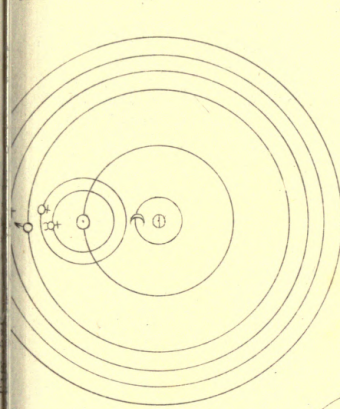
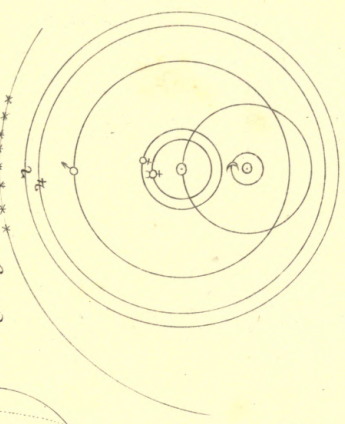


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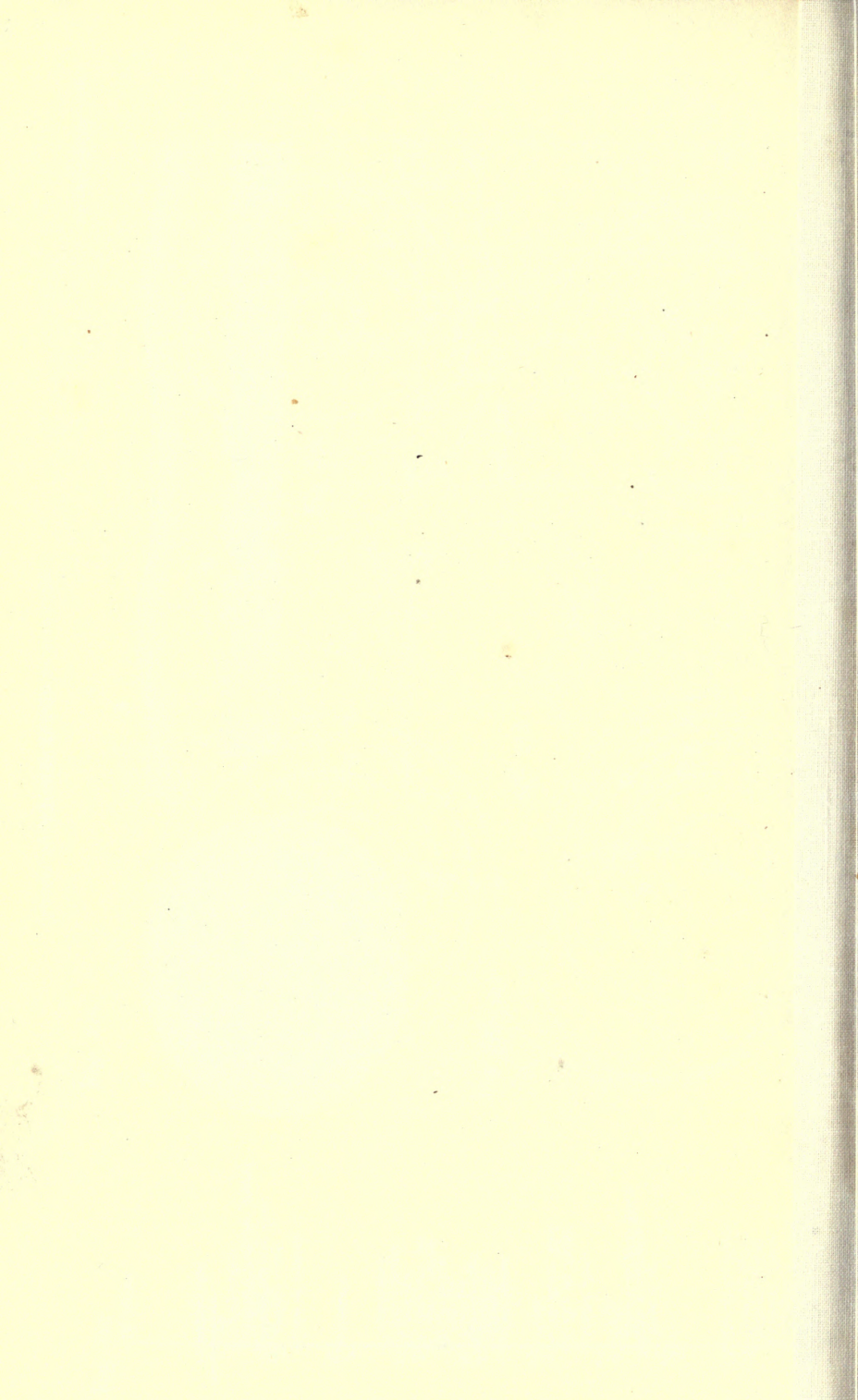


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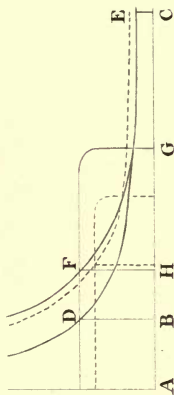


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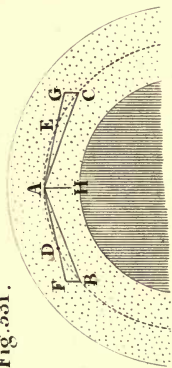


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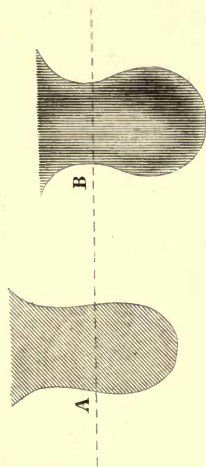


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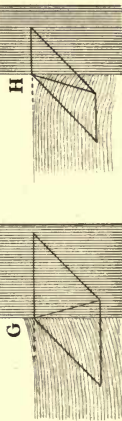
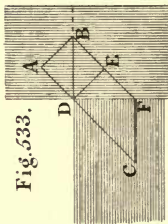


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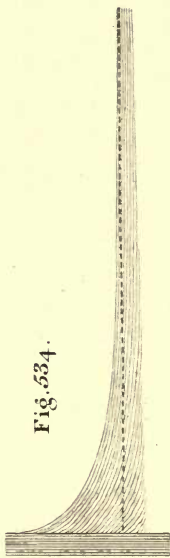


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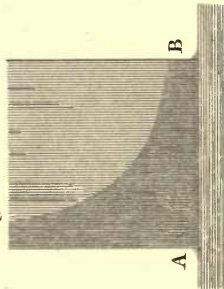


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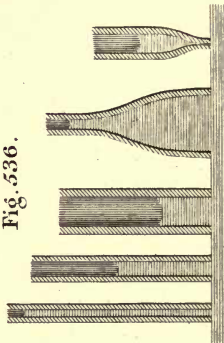


Fig. 537.



Fig. 538.



Fig. 541.



Fig. 539.



Fig. 540.



Fig. 542.



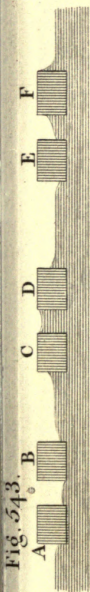


Fig. 544.



Fig. 545.

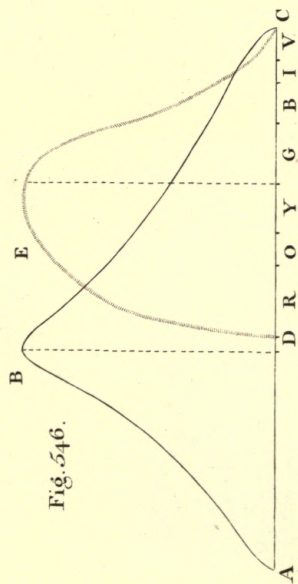
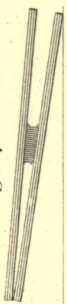


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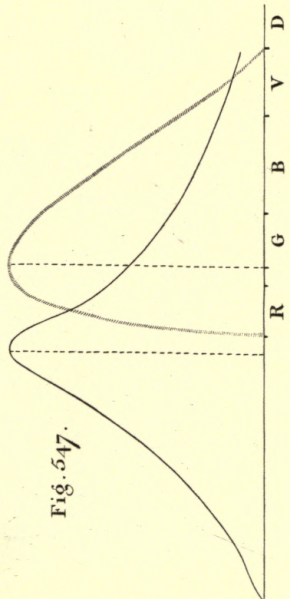


Fig. 547.

Fig. 549.

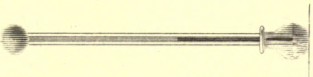


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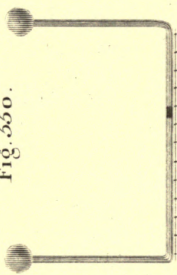


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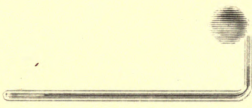
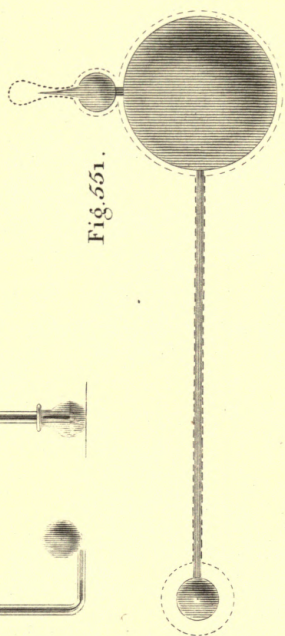


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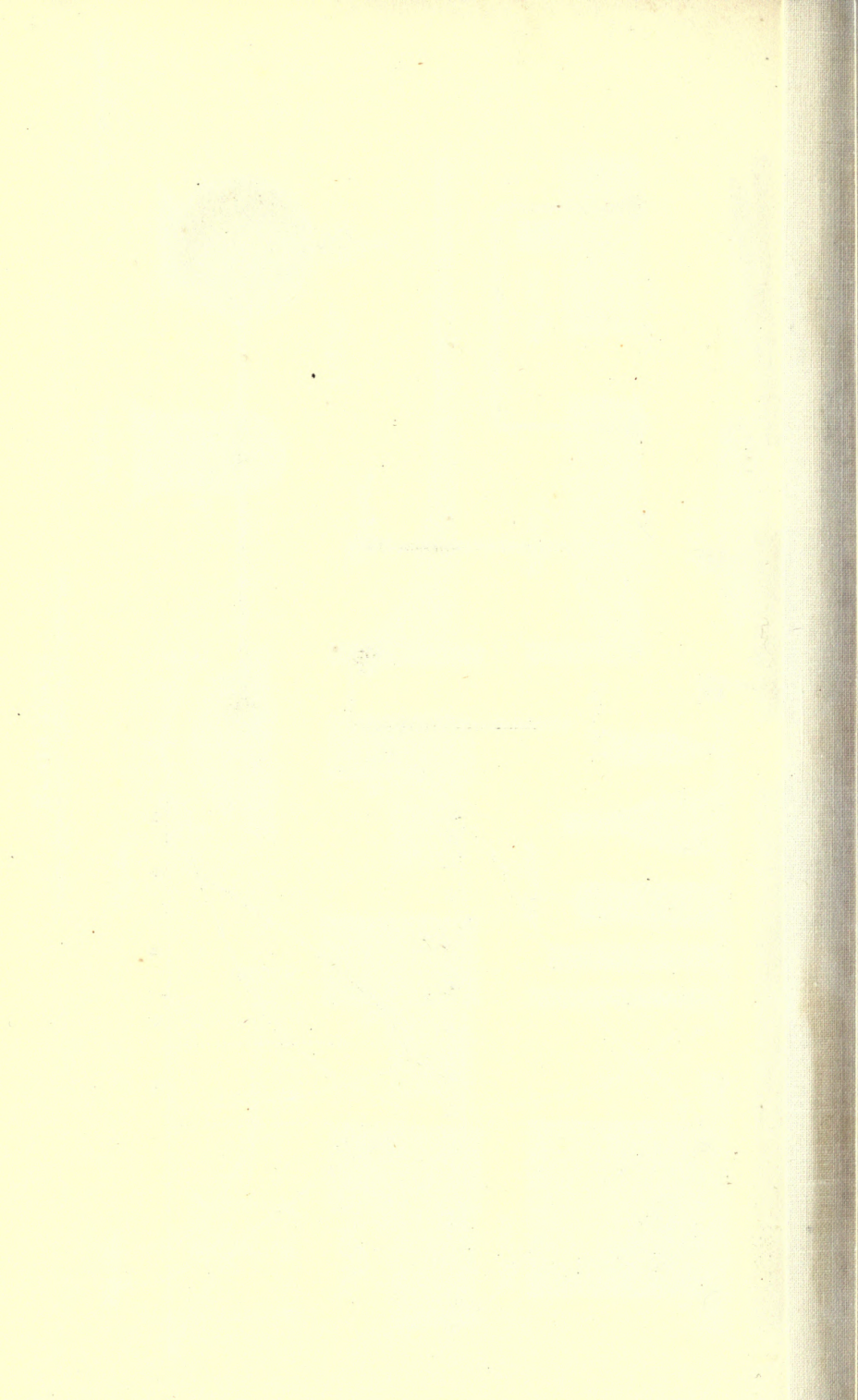




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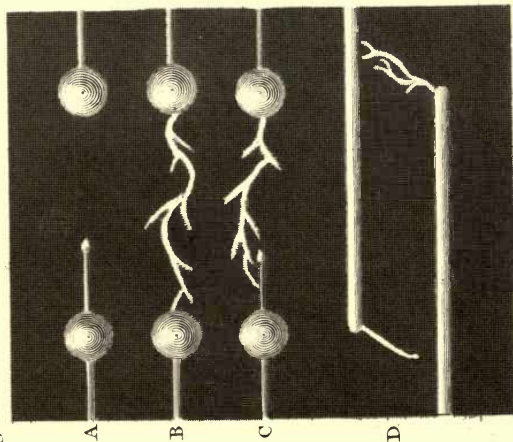


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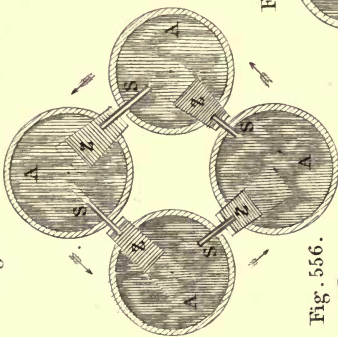


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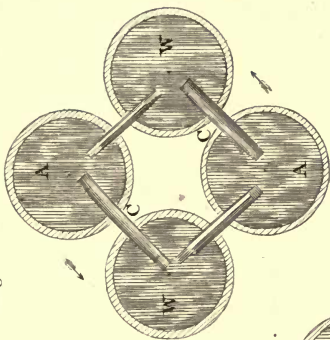


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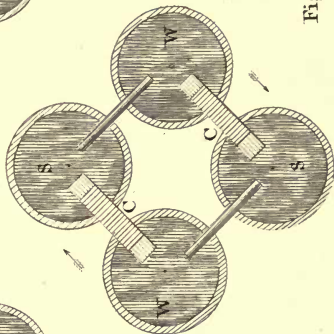


Fig. 556.



Fig. 557.



Fig. 560.

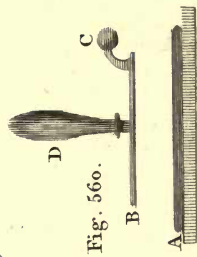


Fig. 559.



SZASZA.....SZASZ

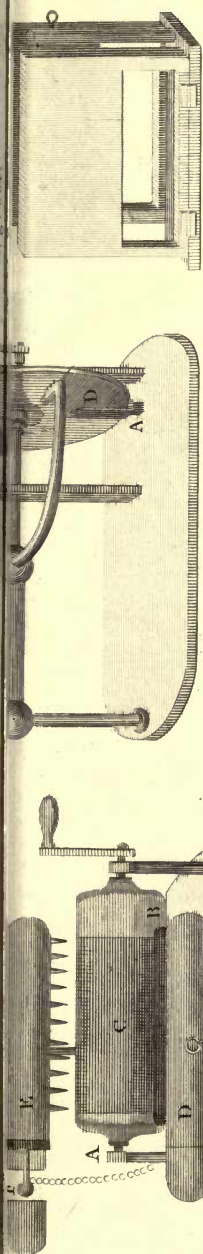


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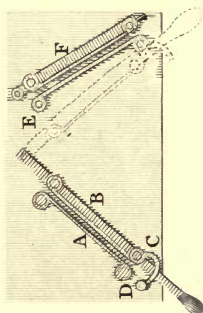


Fig. 563.

Fig. 564. D



Fig. 565.

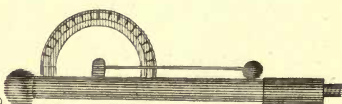


Fig. 566.

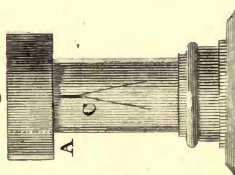
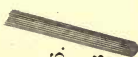


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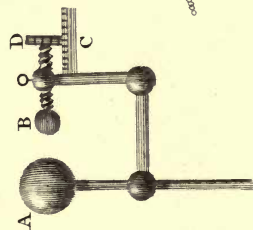


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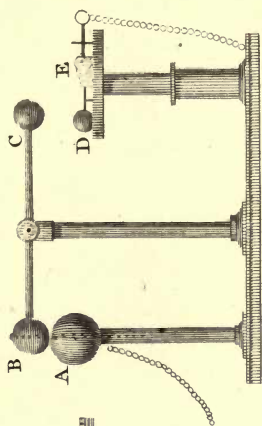


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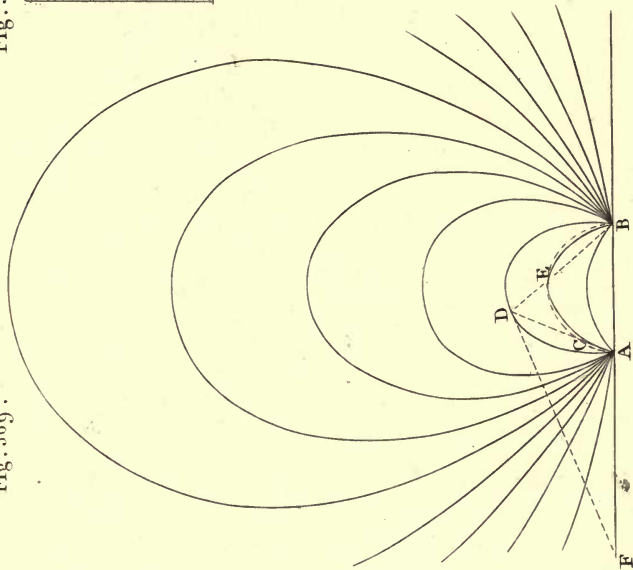


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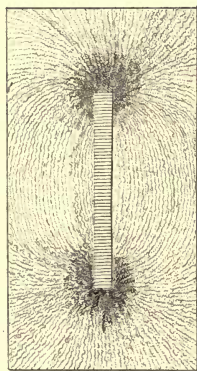


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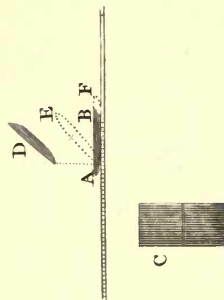


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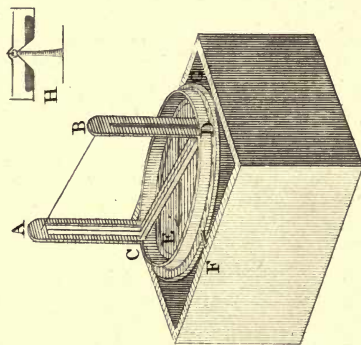


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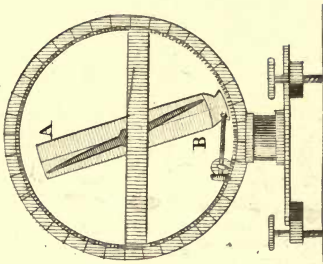


Fig. 574 .



Fig. 576 .



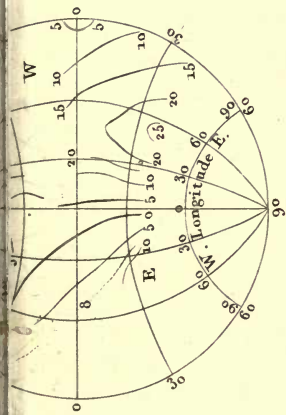


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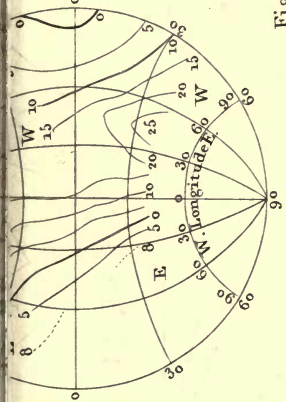


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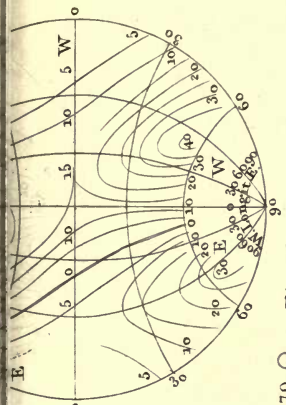


Fig. 579.



Fig. 580.

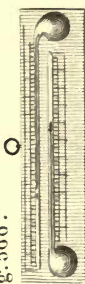


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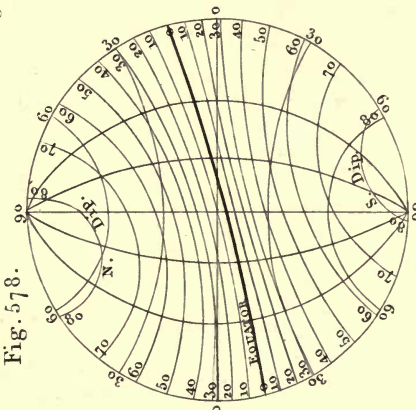


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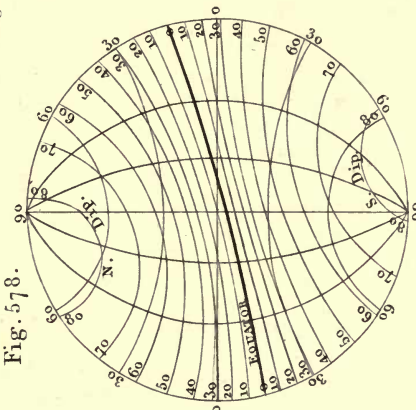


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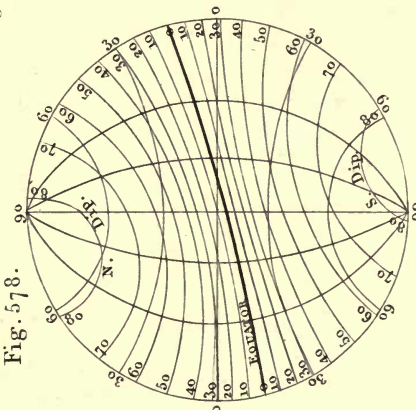


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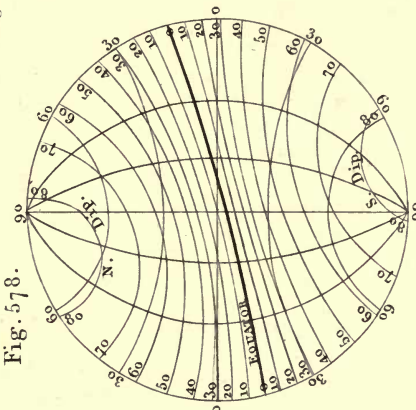


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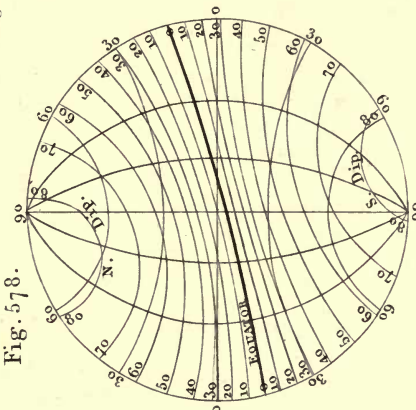
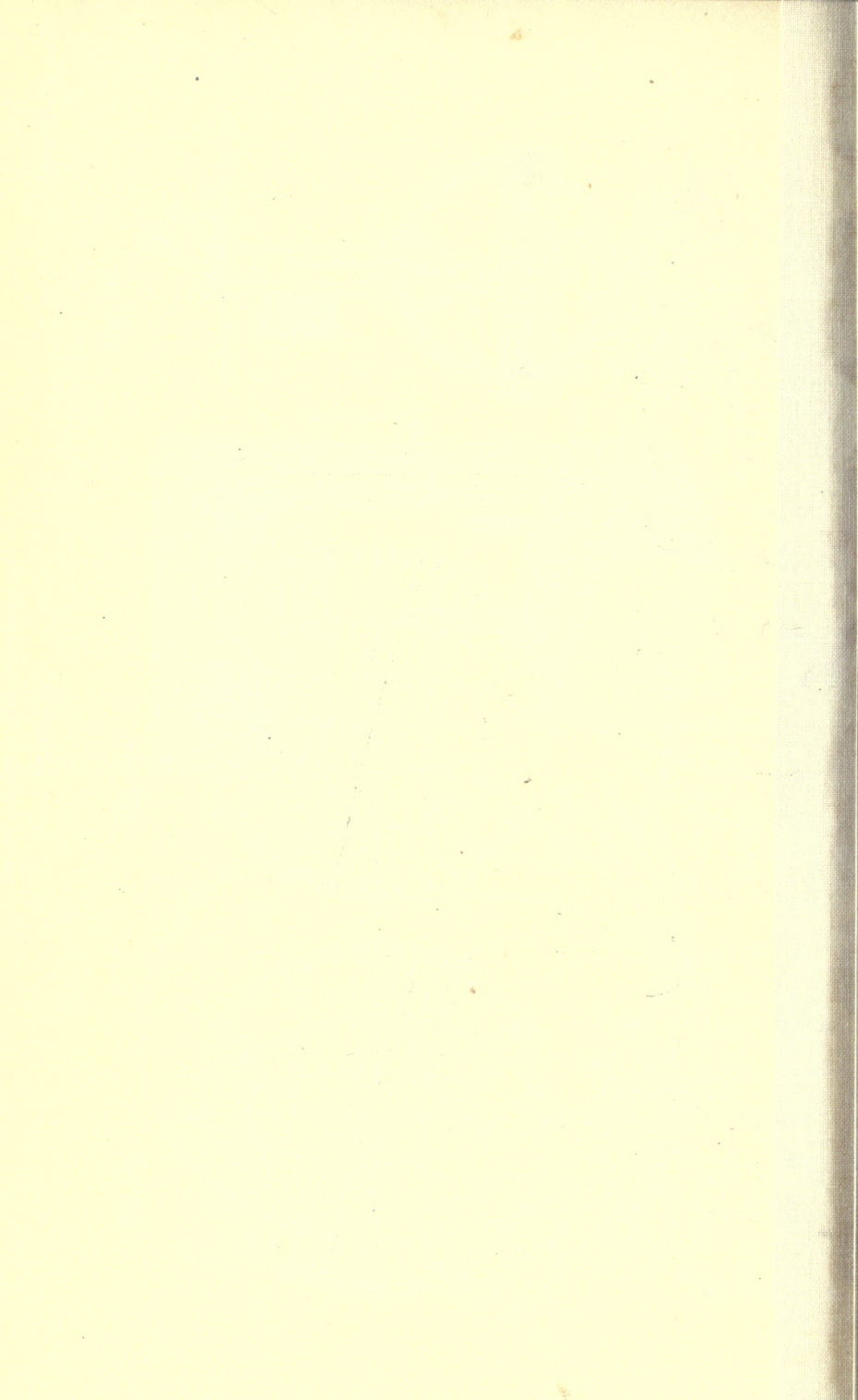


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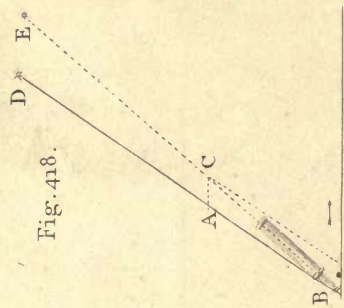


Fig. 418.



Fig. 419.



Fig. 420.



Fig. 421.

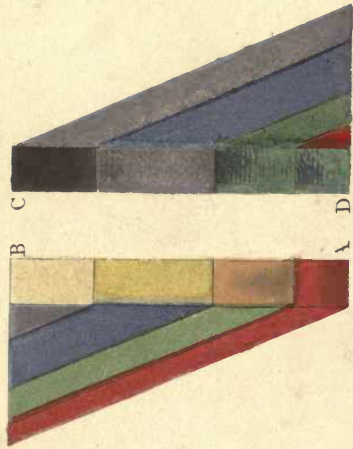


Fig. 422.

Fig. 423.



Fig. 424.



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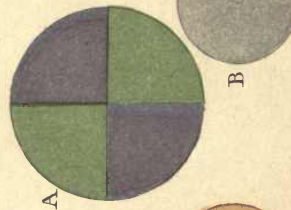


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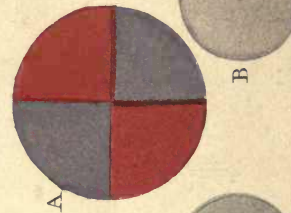


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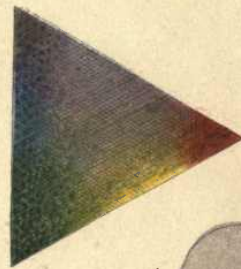


Fig. 428.

Fig. 429.

Fig. 430.

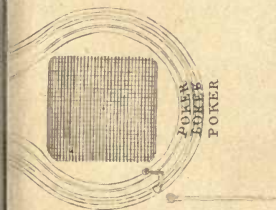


Fig. 432.



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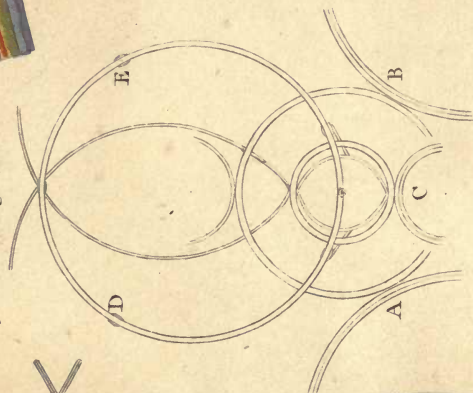


Fig. 434.



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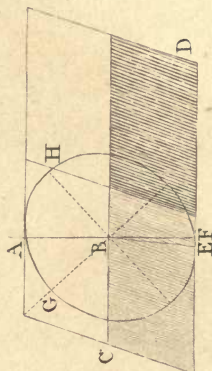
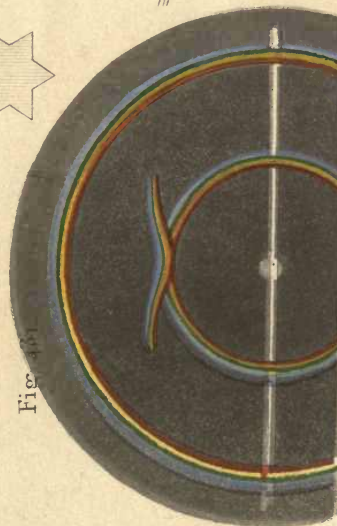


Fig. 436.



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11, NORTHAMPTON SQUARE.

Fig. 436.

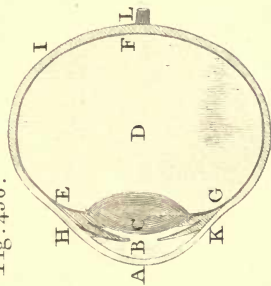


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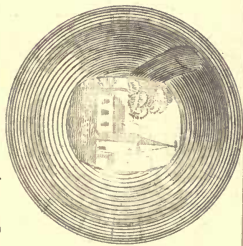


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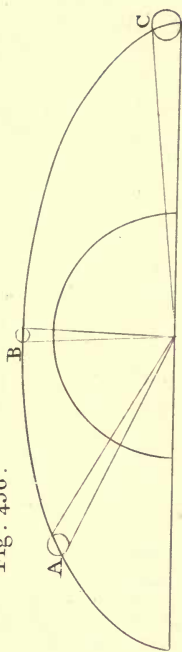


Fig. 439.



Fig. 440.



Fig. 441.

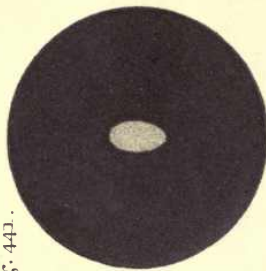


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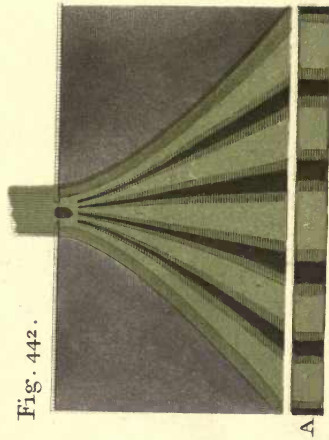


Fig. 443.



Fig. 444.



Fig. 445.

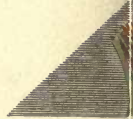


Fig. 446.



Fig. 447.



Fig. 448.

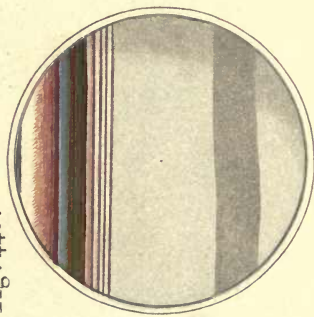


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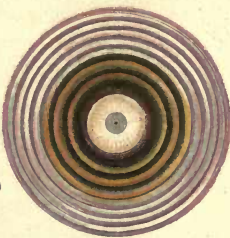


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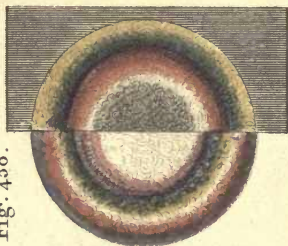


Fig. 451.

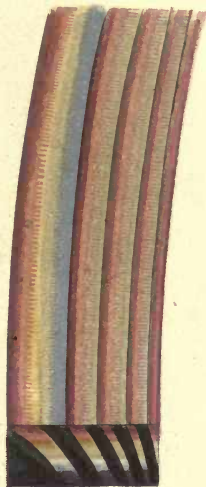
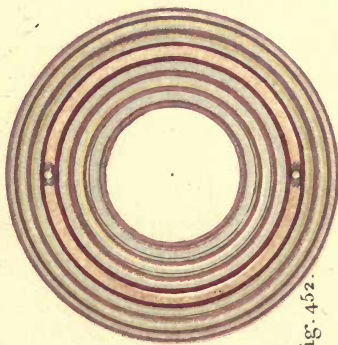
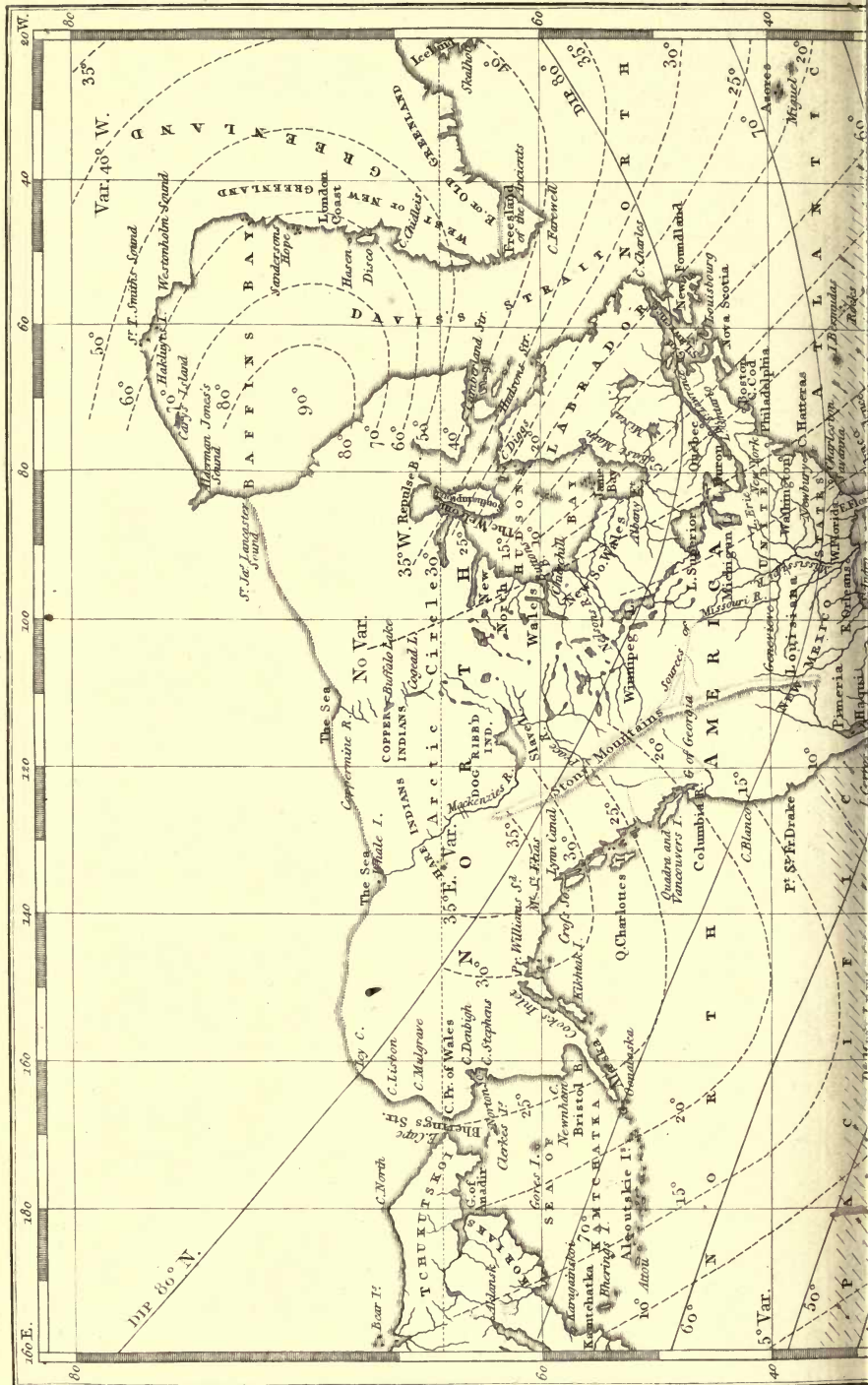


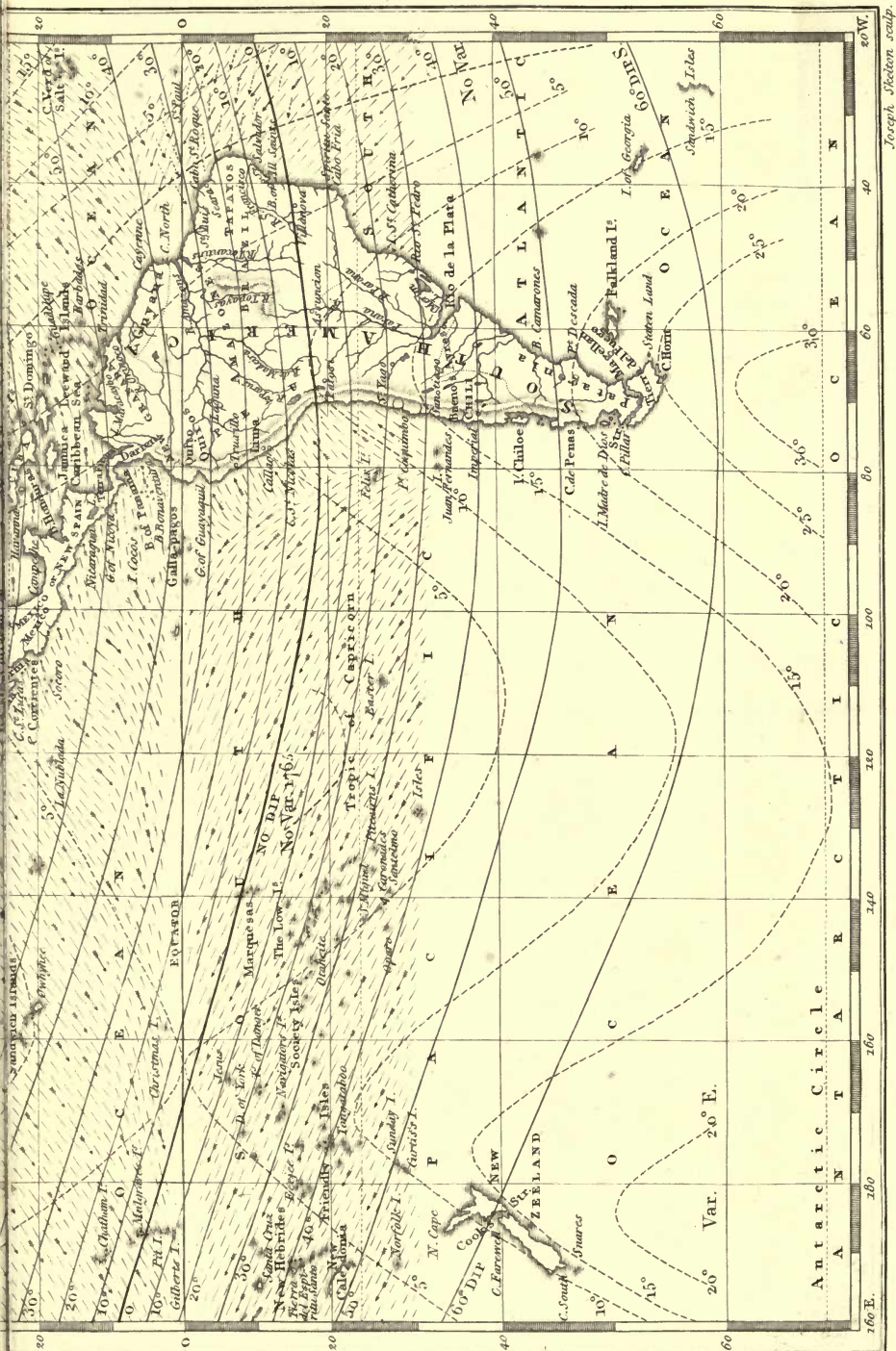
Fig. 452.



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11, NORTHAMPTON SQUARE

PLATE XLII. Fig. 582.





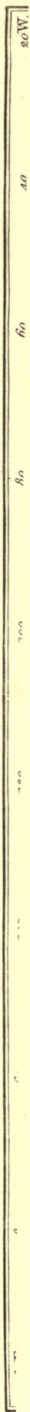
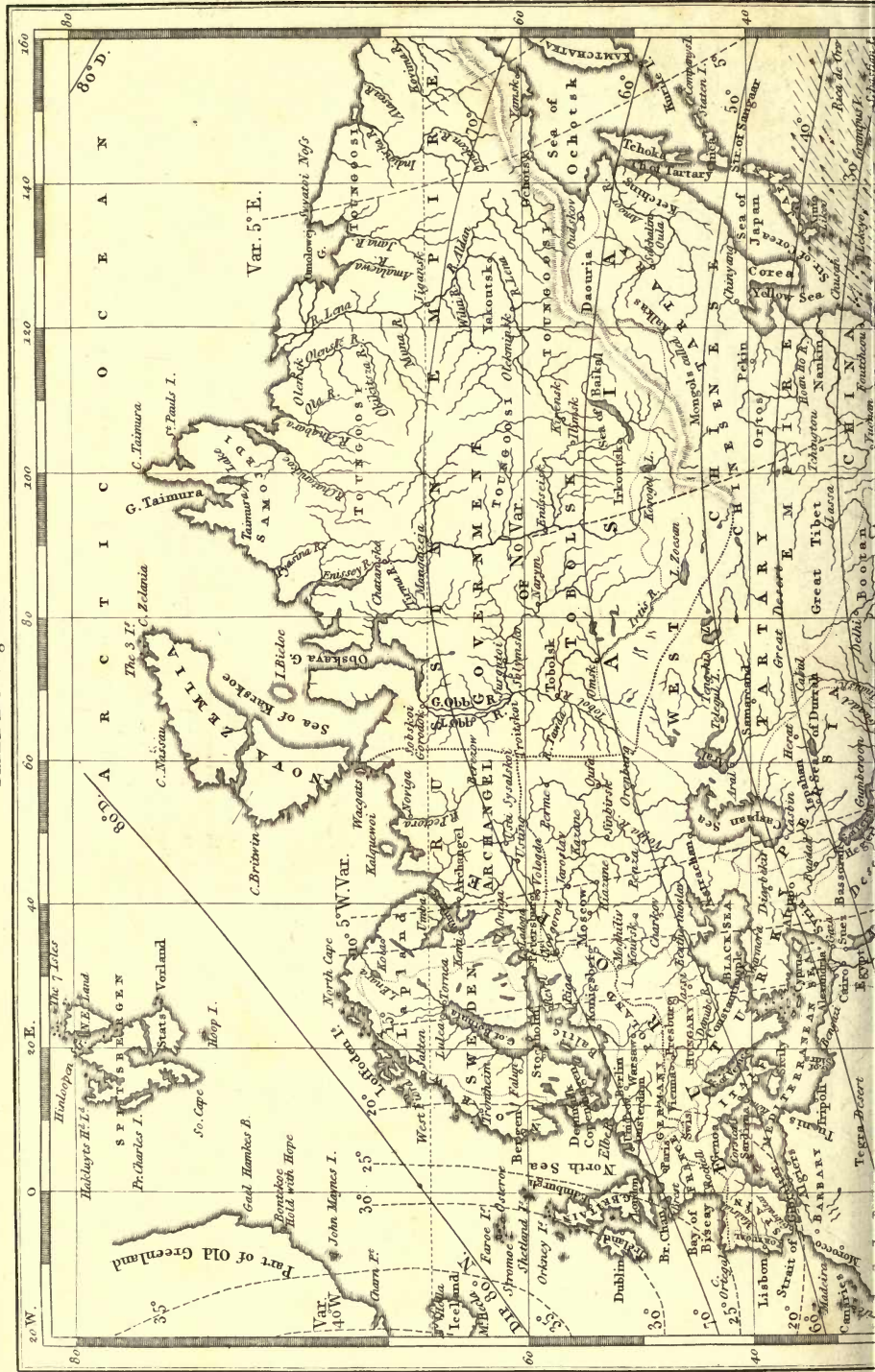
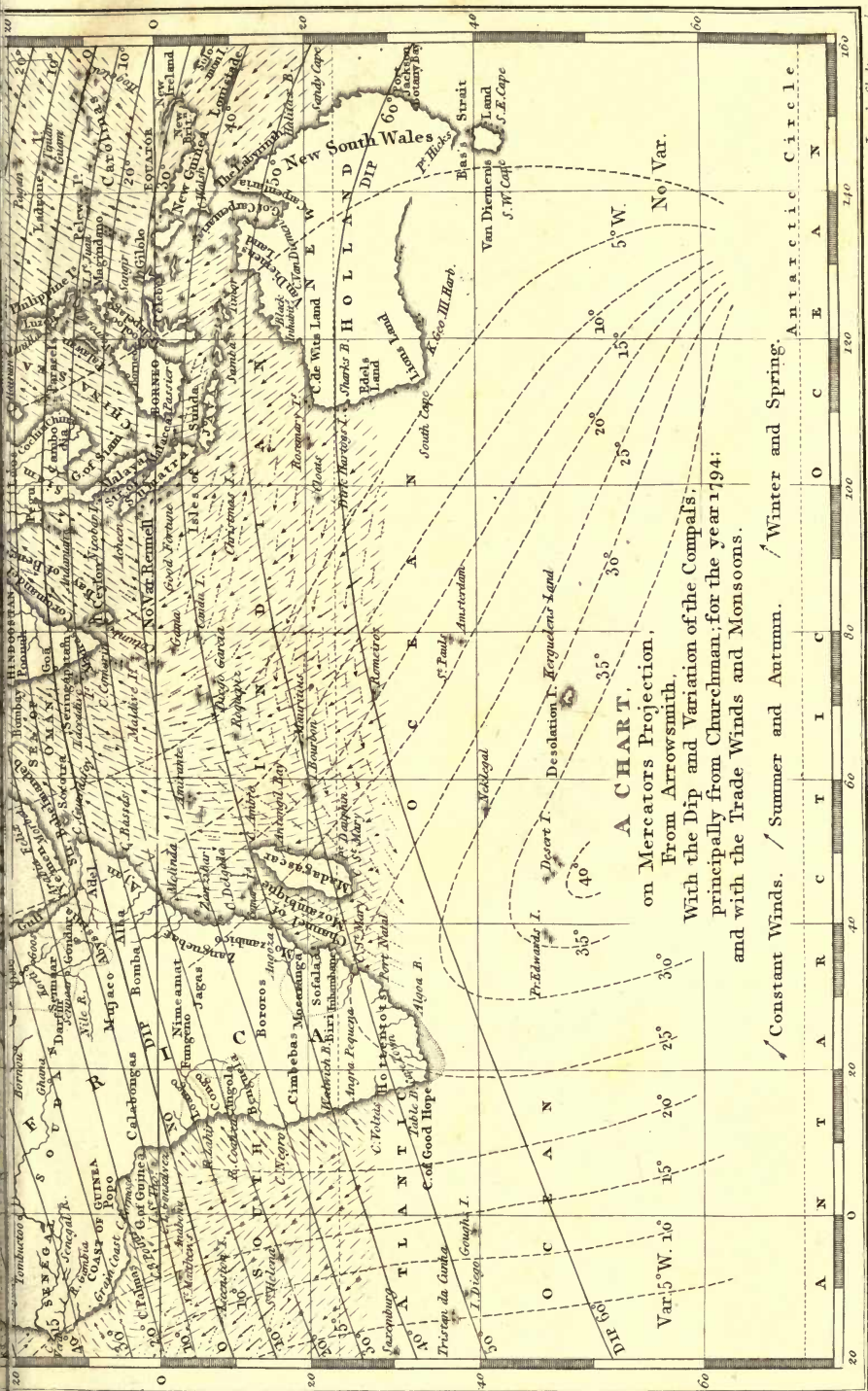


PLATE XLIII. Fig. 582.







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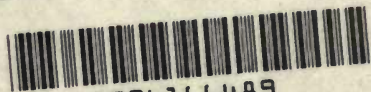
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